ILLUMINATING ENGINEERING

JULY, 1949

Duration and Intensity of Sunshine
Open Troffers for a Kindergarten
Testing Procedures Guides
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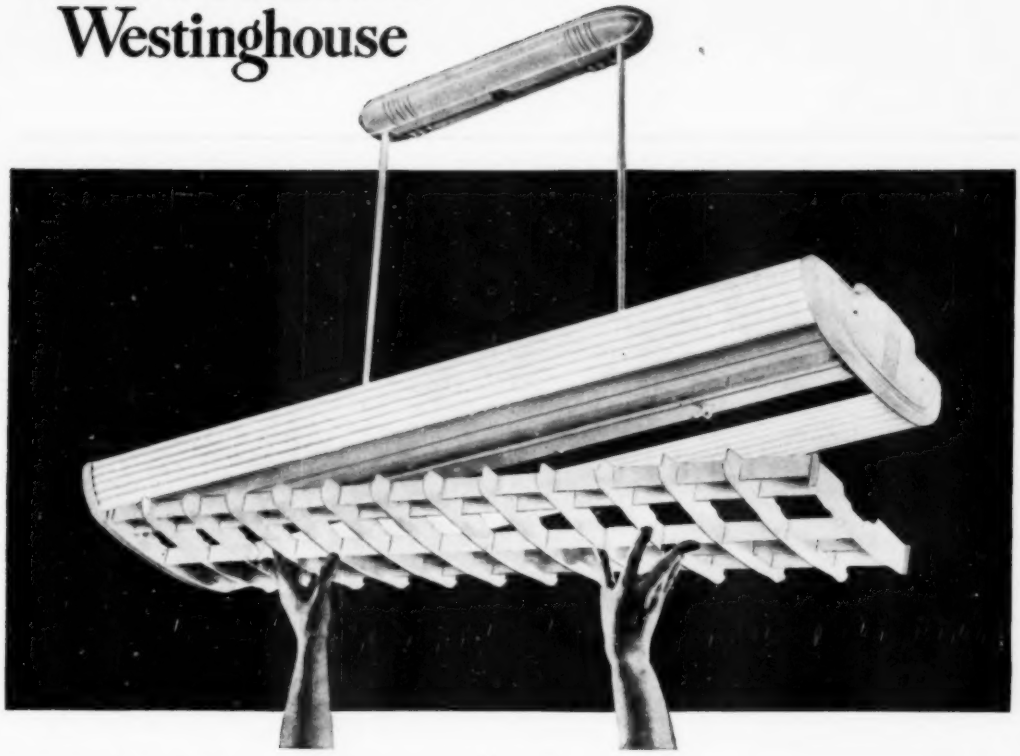

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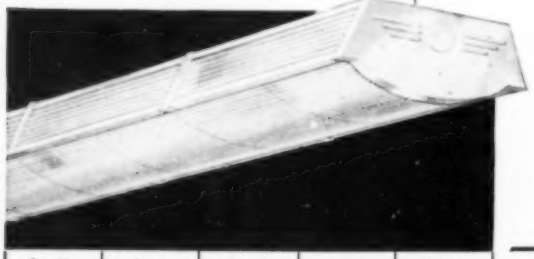

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THE JOURNAL OF THE ILLUMINATING ENGINEERING SOCIETY

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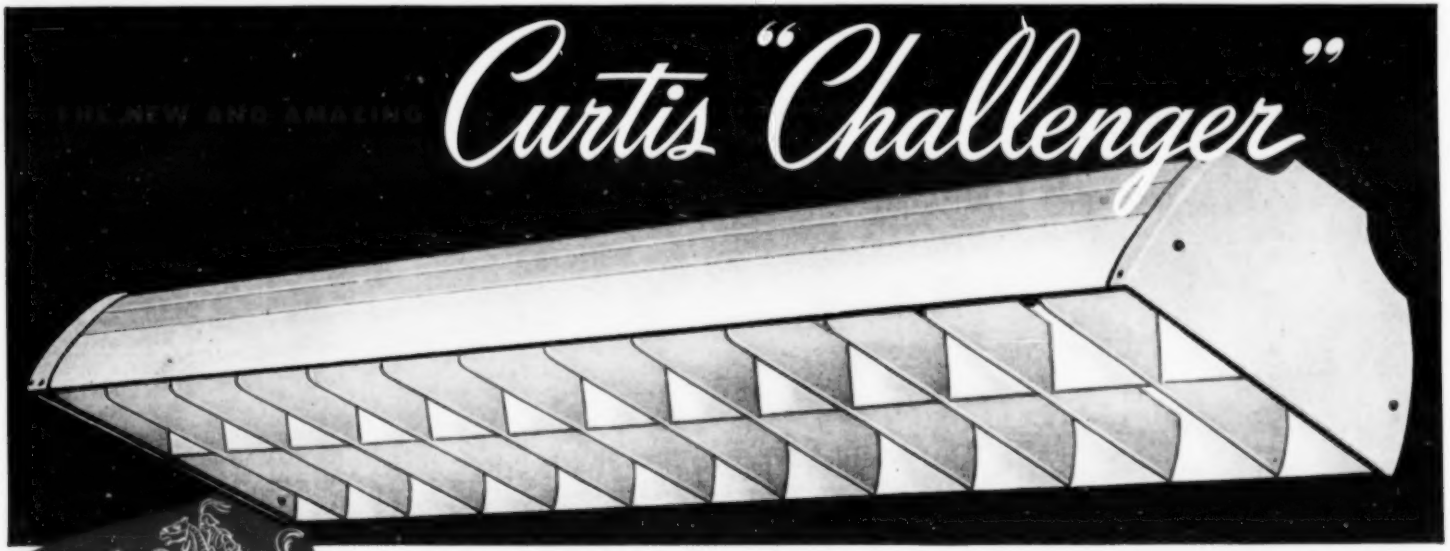

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Open Troffers for a Kindergarten

THE OBJECTIVE in lighting the kindergarten room was to provide adequate quantity of illumination of comfortable quality by means of a system which would require a minimum of maintenance. The installation represents the first class room use of a low-brightness 40-watt T-17 fluorescent lamp in open-bottom recess troffers. The classroom is in a new building northern exposure and a ceiling height of 11 feet.

The installation consists of nine recessed rows of four 5-foot Alzak troffers. Each of these troffers is equipped with a 40-watt T-17 low brightness 4500° fluorescent lamp. No louvers are used because of the low brightness of the lamps. The total power load of lamps and ballasts is 1944 watts or about 2 watts per square foot. The accon.panying measurements of illumination and brightness were made after the installation had been in operation for some 500 hours. However, the troffers and lamps had been thoroughly dusted with a vacuum-cleaner attachment and venetian-blind brush. The time required for this cleaning was about one 5-foot luminaire per minute, an operation representing one of the principal advantages which prompted the use of this type of equipment.

The average footcandle level, on a plane two feet from the floor, was 45.6; the range was from an average of 32 in the corners to 60 footcandles at the center of the room. The lumens delivered to the working plane were 43,900 out of a nominal generated lumens value (new) in the lamps of 75,600 subject to some depreciation because of 4 months' use.

Information for this item supplied by Leonard V. James, Illuminating Engineering Consultant of Chicago and La Grange, Illinois.

Kindergarten room in Western Avenue School, Flossmoor, Illinois, is example of lighting installed in all of the rooms of this school.

Task brightness averaged 34.2 footlamberts, assuming a 75 per cent reflectance reading task, values ranging from 24 near the corners to 45 at the center of the room. The nominal brightness of the lamps used is 920 footlamberts. Compared with 1610 footlamberts for the 4500° T-12 40-watt lamp, this represents a reduction of nearly half in the sheen brightness of glossy paper or other material.

Brightness ratios reported herewith were measured from the stations indicated, about 8 feet from the west wall and 3 feet from the floor. In the accompanying tabulations, these readings are compared with the recommendations indicated by the American Standard Practice for School Lighting and by the National Council on Schoolhouse Construction. The reflectance of the task is uniformly assumed at 75 per cent.

Brightness Ratios

	Flossmoor	ASPSL	NCSC
Maximum Ratio between task and table top. (75:W-Refl.)	1 to 5/8	1 to 1/3	1 to 1/3
Maximum Ratio between task and floor. (75:U-Refl.)	1 to 4/10	1 to 1/10	1 to 1/5
Maximum Ratio between task and lower front wall. (45:L)	1 to 1/5	1 to 1/10	1 to 1/5
Maximum Ratio between task and lower side wall. (45:P)	1 to 1/3	1 to 1/10	1 to 1/5
Maximum Ratio between task and front tack board. (45:N)	1 to 2/9	1 to 1/10	1 to 1/3
Maximum Ratio between task and ceiling. (45:F, 45:E)	1 to 1/5 1 to 1/6	1 to 1/10	1 to 1/5
Maximum Ratio between task and No. 5 luminaire. (24:H)	1 to 5		1 to 50
Maximum Ratio between No. 5 luminaire (about 35° above horizontal line of sight) and the adjacent surface. (H:F)	13 to 1	20 to 1	
Maximum Ratio task to peripheral field. (24:Lamp, 45:J)	1 to 38 1 to 0.09		1 to 50 1 to 0.2
Maximum Ratio task to surrounding field. (24:G, 45:J)	1 to 2.3 1 to 0.09		1 to 10 1 to 0.2

Interior Finishes

Ceiling: Off-white acoustical pans

Walls: Light-weight block
East wall: soft gray
South wall: grayed peach
North wall: grayed yellow
West wall: light gray

Floors: Variegated white and gray asphalt tile

Desks: Natural wood, dull finish

Reflectances — per cent

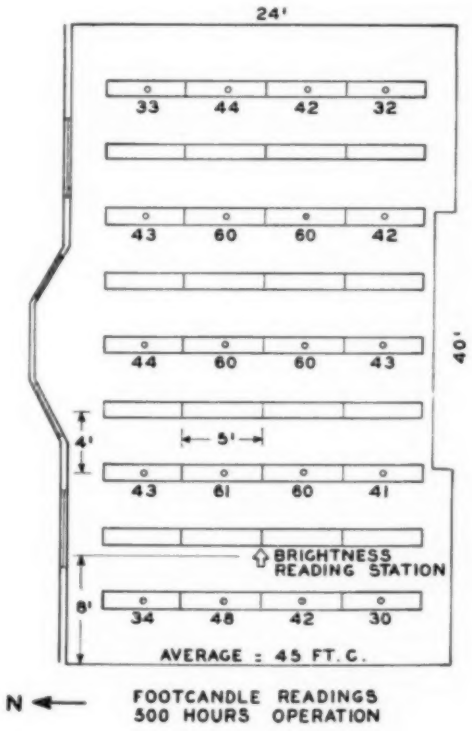
Location	Flossmoor	ASPSL	NCSC
Ceiling	80	80 - 85	85
Upper Walls	55	50 - 70	50
Lower Walls	50	50 - 70	40
Trim	66	30 - 40	40 - 60
Tackboard	66	50 - 60	—
Chalkboard	—	15 - 20	30 max
Tables (desks)	47	35 - 50	30 - 40
Floor	29	15 - 30	30 - 40

Brightness of Luminaire

From laboratory data. 90° is horizontal viewing. 0° is directly below.

Viewing angle	Footlamberts across axis	Footlamberts along axis	Permitted by ASPSL
0°	920	920	2000
45°	912	866	900
60°	114	730	450
75°	46	456	450

Note: Lamps are about 9 ft. above line of sight of sitting child looking along axis of troffer. Only in exceptional cases can such a child get so far from beneath either end of the row of troffers that the lamp appears less than 30° above the line of sight, such that the 60° position in the above table would be a viewing position. Cut-off crosswise is about 50° (shielding angle 40°).



Duration and Intensity of Sunshine

Part V—Architectural Applications

By FRANK BENFORD

PEOPLE are interested in sunshine for two opposing reasons. Windows are made to admit sunshine and shades are made to keep it out. This situation is not so illogical as it seems because we are omitting an important factor—the diffused light from the sky. If our only problem was the control of sky light the matter would be greatly simplified and natural illumination in the interior of buildings would probably be much more satisfactory from both the utilitarian and the esthetic points of view. The manipulation of a window shade to gain a satisfactory reading intensity is relatively easy when the source of natural light is the sky. Slight adjustments of the shade make just perceptible changes in illumination and here there may be a real control of illumination to get satisfactory values at selected points in a room.

When sunshine enters the room, the normal reaction is not to control it, but to exclude it by pulling the shades the whole way down. Here the action tends to be all or nothing, with but little real adjustment to a desired level. The common reaction when sunshine falls on the desk we are using is to completely exclude the sunshine, and then feel slightly surprised at the darkness of the office. The next move is to turn on all the lights in an endeavor to bring the illumination up to the level demanded by our over-exposed eyes. After several minutes, we are again adapted to our environment and at ease.

Aside from questions of visual ease or usefulness, there is often an element of danger when direct sunshine enters a window. In a machine shop, for example, bright sunshine on metal surfaces may set up a real hazard for the machinist and again the reaction is for all or nothing. The storekeeper has somewhat the same problem in his show window, and the school room should be carefully watched to prevent the entrance of rays that can set up an illumination of 10,000 ft-c, which is far outside the useful level.

A different set of reactions occurs when dealing with sunrooms or sleeping quarters. Here we may desire a maximum amount of sunshine throughout the day or a maximum at certain times and a minimum at other times of the day. The sleeping habits of the occupant of the sleeping porch may make it desirable to face it eastward or westward depending upon his sleeping hours. Again, the temperature desired, particularly during the first part of the night, may be the deciding factor in selecting the orientation of the sleeping quarters. Sunshine is thus to some degree at least a 24-hour problem, and the data of this paper are intended as basic information with which a solution, or at least a working compromise, may be found.

Thickness of Walls and Hours of Admission of Sunshine

The restriction of entrance of sunshine by the thickness of building walls is an important factor,

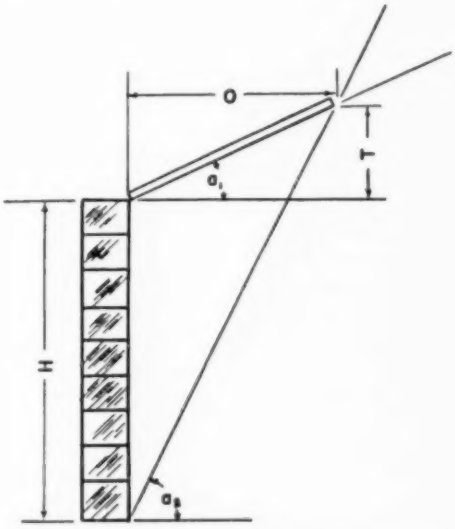


Figure 46. Diagram used in deriving equations for a shield that will permit full sunshine on a wall facing due south on December 21 and no sunshine on June 21.

This is the last of the series on Duration and Intensity of Sunshine, prepared by the late Frank Benford, General Electric Co., Research Laboratory, Schenectady, N. Y. Part I was published in the May, 1947 issue of ILLUMINATING ENGINEERING (p. 527); Part II in the November 1947 issue (p. 877); Part III in the May, 1948 issue (p. 533); and Part IV in the July, 1948 issue (p. 699).

and an extremely variable one. A dwelling house may have an effective window opening that is four times the thickness of the walls, while the office in which this is being written has a ratio of only 2 to 1. In the case of the factory or laboratory, the need for heavy construction is fairly obvious, but the reason for the thick walls of municipal buildings is not so apparent. Reason or no reason, the control of sunshine is much influenced by the ratio of the window opening to the wall thickness or more properly, by the depth of the active edges that determine the angle of cut-off. In general, the wall thickness is more of a factor in high latitudes than it is near the equator. In the equatorial regions the direction of the wall may be such as to admit sunshine during the middle of the day, but at the same time, the altitude of the sun may be great and the sunshine penetrates only a short distance into the room. At high latitudes the sun will be closer to the horizon and the entering sunshine may cover the width of the room. For this reason, a solution for the altitude a should always be made to determine the probable importance of entering sunshine.

In Table V some typical data are given for the simple case of walls facing due south and having window cut-off panes 0°, ±15°, and ±30° with the plane of the wall. The angle θ is determined by drawing a diagonal from edge to edge of the window opening, using the edges that are effective in diaphragming the entering sunshine. It happens occasionally that due to the presence of a pilaster the entering angles will differ for the two diagonals. Planes drawn through the active edges set the limits for the entrance of sunshine, and these planes at an angle θ with the plane of the wall are used in connection with Figs. 47 to 53 to determine the times of beginning and ending of entrance of sun-

TABLE V
Effect of Thickness of Walls on Entrance of Sunshine

Latitude 45°N				
	Window Angle	$\theta = 0°$	±15°	±30°
June 21	On	7.75 a.m.	9.00 a.m.	9.95 a.m.
(4.22 a.m. to	Off	4.31 p.m.	3.10 p.m.	2.10 p.m.
7.83 p.m.)	Elapsed	8.56 hr.	6.10 hr.	4.15 hr.
December 21	On	4.30 a.m.	5.80 a.m.	7.30 a.m.
(7.58 a.m. to	Off	7.70 p.m.	6.18 p.m.	4.70 p.m.
4.35 p.m.)	Elapsed	15.00 hr.	12.38 hr.	9.40 hr.

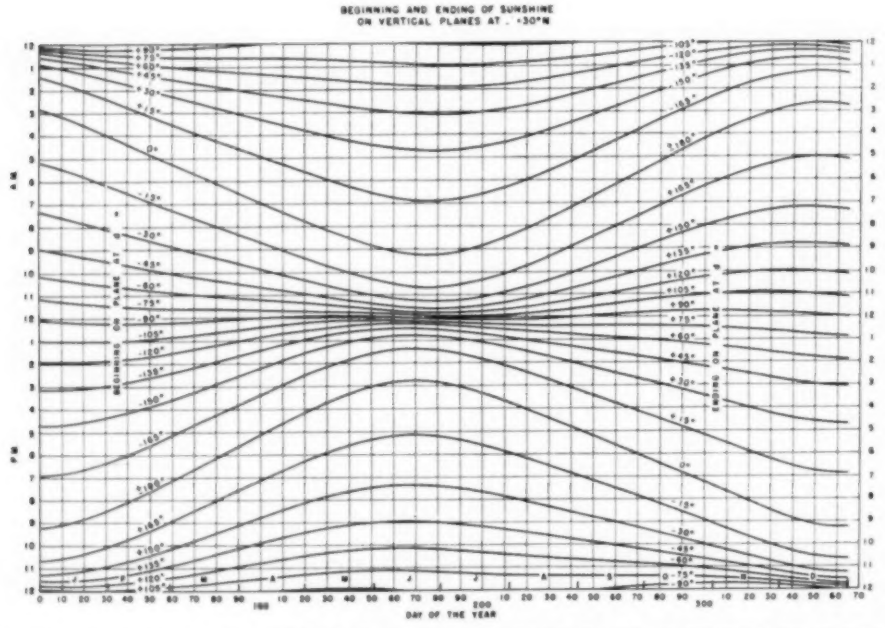


Figure 47. In this and the remainder of the Figures, each curve represents the time of day (mean sun corrected for equation of time) at which sunshine begins and ends for selected vertical planes. This Figure is for latitude 30 degrees north latitude. The variables are time of year, time of day, and orientation of plane, and with two of these factors known, the third may be determined. For times of beginning, the d-scale on the left is used, while ending of sunshine uses the right-hand d-scale.

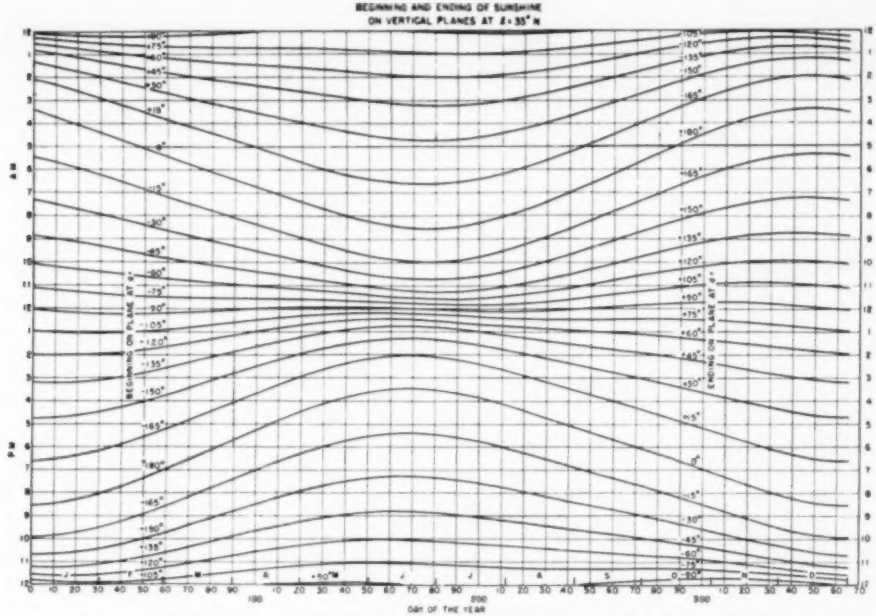


Figure 48. Beginning and ending of sunshine on vertical planes at 35 degrees north latitude.

shine. Two dates are used in Table V, June 21 and December 21, and with each is given the hour of sunrise and sunset, and the latitude is 45 degrees north.

For the case of no thickness of wall θ equals zero, and the June 21 sun crosses this plane at 7.75 a.m. (when $d = 0$ and the site is on the standard time meridian). Referring to Fig. 50 and using the ordinate for June 21, the curve for the 0 degree plane crosses the ordinate at 7.75 a.m. for the beginning of sunshine, using the d-scale at the left to identify the plane, and the ending time is 4.31 p.m. using the d-scale on the right. Since these times are within the hours of daylight (as given under the date in the Table), the elapsed time of 8.56 hours is the correct solution for the duration of sunshine entering the window.

When the wall has sufficient thickness to turn the limiting planes 15 degrees to the plane of the wall, the time of entrance is 9.00 a.m. (curve —15°, beginning d-scale, Fig. 50) and of ending 3.10 p.m. (curve +15°, ending d-scale, Fig. 50). The elapsed time is 6.10 hours, a loss of 2.46 hours due to the thickness of wall.

For the thickest wall, $\theta = \pm 30°$, there is a further reduction of 1.95 hour, or a total reduction of 4.41 hours. These figures do not apply to the entrance of sky light, and they are not a measure of anything except the period during which sunshine enters the windows.

The solutions for December 21 are 15.00 hours, 12.38 hours, and 9.40 hours for the three walls, but since all the computed times are before sunrise or after sunset, the real limits of entrance are sunrise and sunset, and the thickness of wall has no effect other than reducing the amount of sunshine that enters.

Orientation of Buildings to Admit or Exclude Sunshine

When the architect is free to face a proposed building in any way he desires, there is a possibility of so arranging windows as to either eliminate shades and louvers or to minimize their use. The factors that enter into the problem are the latitude and longitude of the building and the thickness of the building wall as compared with the effective width of the window opening. Also in the case of a school, the time of year during which school is held and the hours of assembly and dismissal are factors.

The specific problem is to find if it is possible to have one wall of the building oriented so that sunshine will not enter during a school session, and if there is some freedom allowed the architect in the azimuth direction of the wall containing the windows.

Let us assume the following data for a public school:

Latitude	30°N
Longitude	75°W
Thickness of Wall	10 inches
Width of Window Opening	36 inches
Beginning of Term (248th day of year)	September 5
Ending of Term (176th day of year)	June 25
Assembly, E.S.T.	8.33 a.m.
Dismissal, E.S.T.	3.66 p.m.

Since the noon sun is in the south throughout the year for the assumed latitude of 30 degrees, it is evident that the windows must not face south. Also, since the morning sun is in the east, and the setting sun in the west, these two directions are excluded, leaving only northern exposures to be investigated.

The assumed window proportions reduce the entrance angle by 15 degrees on either side so that only 150 degrees of horizon is visible. If the windows faced due north, the limits on the horizon would be from $d = +105$ degrees to $d = -105$ degrees, or 15 degrees from the plane of the wall in each case. These angles are the directions in which the limiting planes, as determined by the diagonals of the window frame, cut the horizon. But the convention is to define a plane by the direction of its normal. The normals in this case are +195 degrees for the morning sun and −195 degrees for the afternoon sun.

Referring to Fig. 47, on June 25, the 176th day of the year, the sun will cease shining on a plane having $d = -174$ degrees at 8.33 a.m. (8.30 mean sun), the time of assembly. But a wall facing −174 degrees is turned 6 degrees west of due north, that is, away from the morning sun. The assumed window proportions provide a 15 degree shadow, so there is left the possibility of turning the building 9 degrees to the east without admitting morning sunshine. The afternoon solution is almost identical, giving 9 degrees of freedom toward the west. The total freedom of orientation is 18 degrees, 9 degrees on either side of due north. This does not provide any great freedom for the architect in placing the building, but it at least gives him permissible limits that might be a guide in the selection of sites, or it may aid only in selecting the wall that is to contain the windows for a school room.

Let us repeat the solution for a school farther north, say at 45 degrees latitude. On Fig. 50 at 8.33 A.M. on the 176th day, the point is between the curves for $d = +165$ degrees and $d = +180$ degrees, at about $d = +174$ degrees. This is 6 degrees east of due north, and the added angle due to wall thickness makes it permissible to face the wall 21 degrees east of north. The planner of the

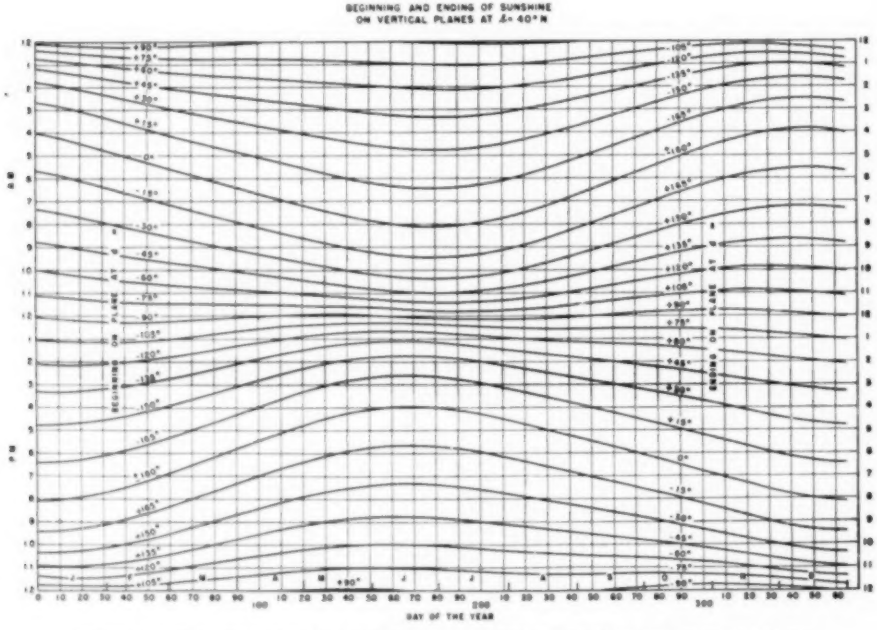


Figure 49. Beginning and ending of sunshine on vertical planes at 40 degrees north latitude.

building thus has a latitude of 42 degrees in its orientation.

The afternoon solution is substantially the same as the forenoon solution since 8.33 and 3.66 are at equal intervals from noon. If the school is on daylight saving this symmetry will not exist and separate solutions must be made for morning and afternoon. The wall in this case will be turned slightly toward the west. No solution need be made for September 5, the opening date, since the sun is near its northern limit on June 25, and a solution on this date for the exclusion of sunshine is satisfactory for the remainder of the year.

Heating by Sunshine

During the last few years there has been considerable engineering study of the problem of utilizing the sun's radiation for heating buildings. In these studies, advantage has been taken of the one-way characteristic of glass for sunshine and its reradiation from surfaces at near body temperature. This is the familiar greenhouse effect, where sunshine (about 6000°C) and much of the infrared, find ready passage through glass, but upon reradiation from surfaces at 20°C, the glass acts as an effective barrier to the outward flow of energy.

The atmosphere is most transparent for radiation in the visible spectrum and the losses for the sun's radiation are highest in the ultraviolet, below 3500A, and in a number of bands in the infrared. Since the peak of power in the sun's spectrum is near the center of the visible spectrum, it follows that the luminous component of sunshine is much less influenced by the atmosphere than is the spectrum as a whole. The heating value of sunshine is nearly independent of wavelength; that is, a watt in one part of the spectrum is as valuable as a watt in any other part. The losses in the infrared due to water vapor and carbon dioxide in the atmosphere are, therefore, important from the point of heating, and of no importance from the point of illumination. In general, the heating effect varies more rapidly than the illuminating effect as the path length in the atmosphere changes, and the data that have been given for illumination cannot be taken as measures of relative heating values. In those cases where the wall or window receiving the radiation is not facing directly south, the time of maximum energy will not agree with the time of maximum light, and in fact, the energy problems should be regarded as wholly separate from the problems of light. No attempt will be here made to evaluate energy and attention will be confined to times of beginning and ending which are identical for energy and light.

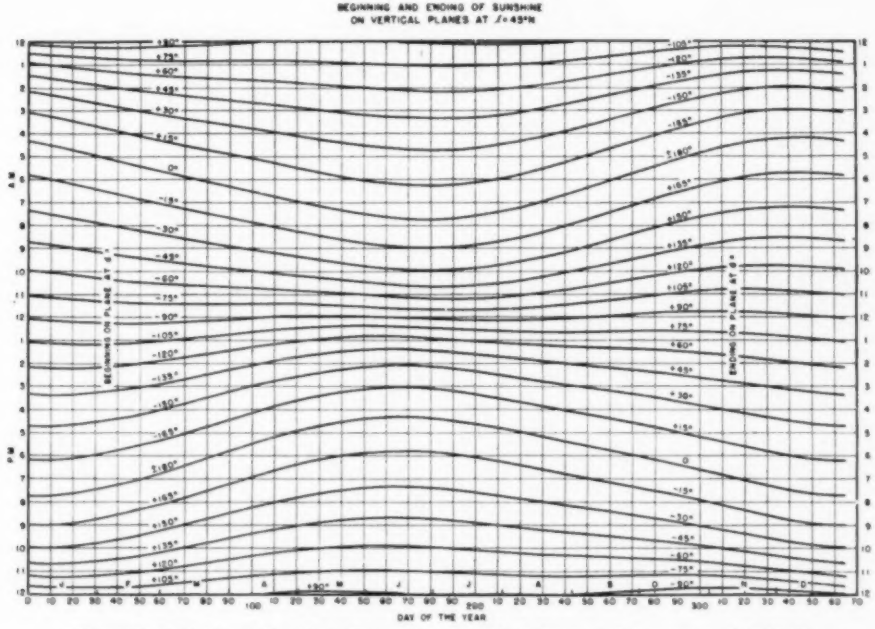


Figure 50. Beginning and ending of sunshine on vertical planes at 45 degrees north latitude.

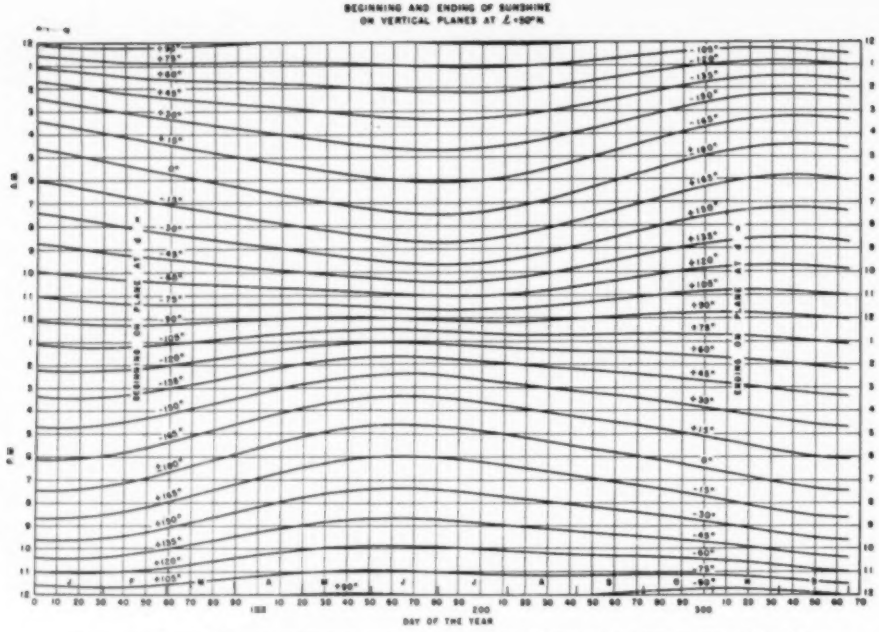


Figure 51. Beginning and ending of sunshine on vertical planes at 50 degrees north latitude.

One plan that has received considerable theoretical and experimental consideration is the window or glass block wall that faces due south, and that is provided with a shading device so that it receives full sunshine (more properly, the full radiation from the sun) in the winter and is shadowed during the hot months when no additional heat is desired.

Assume, as a starting point, that the glass block wall is in latitude l, and that it has an effective height H for the transmitting section. On June 21 the sun has an altitude

$$a_1 = 90 - l + 23°27' \tag{57}$$

while on December 22, it is above the horizon

$$a_2 = 90 - l - 23°27' \tag{58}$$

as is illustrated in Fig. 46. The outer end of the shield has a height T above the top of the glass wall, and it extends horizontally a distance O. Solving for T and O we get

$$T = \frac{H \cot a_1}{\cot a_2 - \cot a_1} \tag{59}$$

$$O = T \tan a_2 \tag{60}$$

The figure is to scale to show full exposure when the sun is farthest south, and no exposure when it is farthest north, the latitude being 43 degrees. In actual construction, both a_2 and O would doubtless be varied to suit the architect or the tenant. It would seem logical to have the shading shield adjustable, if for no other reason than to compensate for unseasonable weather.

Equation 56 showed that the illumination on a vertical surface varied with the cosine of d:

$$\cos i = \sin (l - s) \cos d \tag{61}$$

Since cos d for small values of d (say 10 degrees or less) is nearly unity, this makes it evident that the orientation angle d is not a critical factor, and that a variation of 10 degrees from true south would be of negligible effect.

A greenhouse may receive a maximum amount of energy from the midday sun on some day other than that on which the noon sun is most nearly overhead. If the plants within the greenhouse grow to a considerable height, or are set at some elevation, the obstructing area of the plants for a low sun may exceed the floor area. If this gain in heat receiving area is not cancelled by the greater loss in the atmosphere, there will be a gain in heating effect. The resemblance here to the plane of maximum noon illumination will be recognized, and there are probably many cases where a mathematical exploration would lead to useful information and results.

Use of Shading Fins

A relatively new architectural departure is the use of shading fins designed and built as integral parts of a building. These fins are vertical and are so arranged as to shield the walls, or perhaps only the windows, of a building against direct sunshine. An example of vertical fin design is found in the Chevrolet plant at Los Angeles, California. These fins are concrete slabs 2 feet wide and 7 feet high and they exclude sunshine from the western windows of three major buildings.

This shading device is coming into wide use in Brazil, and a future comparison of architectural practice under the equator compared with practice 34 degrees north of the equator will be of interest. Here the elements of the design are the same as in the case of the school house; but the working hours are different, and the working season is not restricted but extends throughout the year. The data of Fig. 48 apply to Los Angeles, but for location south of 30 degrees, Equation (20) may be used to find the azimuth of the rising and setting sun. This approximation will be close since the equatorial sun rises and sets nearly in a vertical path from horizon.

The attics of our homes are pretty uncomfortable places for living or sleeping throughout the year. In the summer they are too hot and in the winter too cold, but there is a possibility that the shading fins may correct part of the trouble. If the summer temperature can be reduced to a livable level, then it will be worth while to supply heat during the winter and gain valuable floor space that now serves only to accumulate dust.

Assume that shading fins are placed perpendicular to the surfaces of the roof, and that the fins are parallel to the ends of the roof, that is, perpendicular to the ridge. Let the height of each fin (measured perpendicular to the roof) be E and the spacing S. The ratio S/E gives the slope of the shadow plane with reference to the roof, or

$$\tan p' = \frac{S}{E} \tag{62}$$

Since we are here concerned only with the relative values of E and S, we need not assume specific values, but may proportion the fins and their spacing so as to secure the desired shade in each separate problem. This construction would make a roof resemble an air-cooled aviation motor, and there are here distinct decorative possibilities of a functional nature.

Given a roof whose normal has a slope p in direction d, and let the shadow plane, which extends from the top of one fin to the base of the adjacent one, have a normal making an angle p' with the plane of the roof, as illustrated in Fig. 54 (d). This

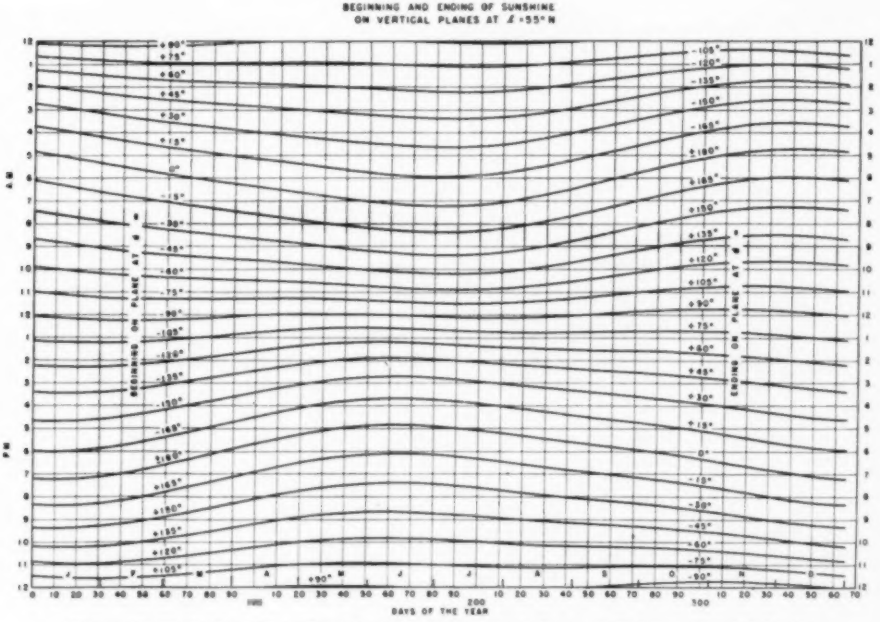


Figure 52. Beginning and ending of sunshine on vertical planes at 55 degrees north latitude.

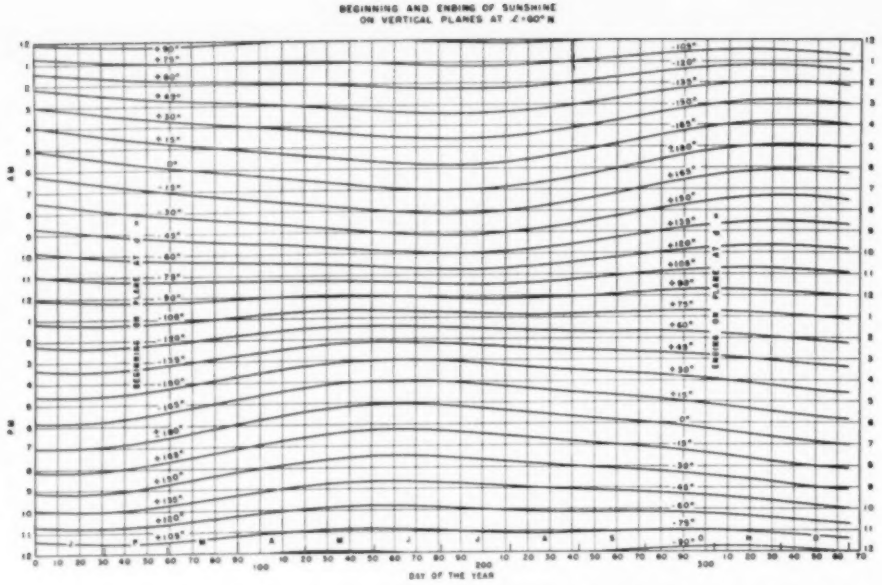


Figure 53. Beginning and ending of sunshine on vertical planes at 60 degrees north latitude.

shadow plane may represent the beginning of illumination of the roof surface between fins, or the ending of inter-fin illumination. The normal to the shadow plane makes an angle p'' with the horizontal plane, and we have

$$\sin p'' = \sin p \sin p' \tag{63}$$

and the normal leans toward a point d' on the horizon such that

$$d' = d \pm 90 \tag{64}$$

where d is the azimuth angle of the ridge of the roof. With p'' and d' known, the time of beginning and ending can be found by the method given in Part II* of this series. For choosing between $+90$ and -90 in Equation (63) a rough pencil sketch is invaluable. In general, the normal to the shadow plane leans away from the sun and this alone will lead to the correct choice of sign.

The vertical shading fin is essentially protection against a sun that is near the horizon, but it is useless in mid-day. In South America there is wide use of horizontal fins or "umbrellas" over the windows. These fins ordinarily are given just enough slope to drain and their extension from the wall is computed for the least elevation a of the sun that will occur during the year. An application of fins

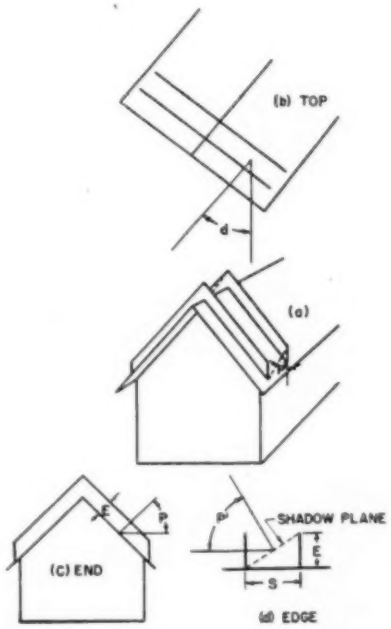


Figure 54. Sketch illustrating the symbols used in deriving Equations 63 and 64 for the exclusion limits of vertical fins on a roof.

*Illuminating Engineering, p. 877, November, 1947.

TABLE VI

Dates in Southern and Northern Hemispheres Having the Same Interval Between Sunrise and Sunset

South	North	Corr. to North	South	North	Corr. to North	South	North	Corr. to North
Jan. 1	July 3	0	May 5	Nov. 7	+13	Sept. 7	Mar. 5	−14
6	8	+ 1	10	12	+12	12	10	−14
11	13	+ 2	15	17	+11	17	15	−15
16	19	+ 4	20	21	+10	22	20	−15
21	24	+ 5	25	26	+10	27	25	−15
26	29	+ 6	30	Dec. 1	+ 8	Oct. 2	29	−15
31	Aug. 4	+ 7	June 4	5	+ 7	7	Apr. 3	−15
Feb. 5	9	+ 9	9	10	+ 6	12	9	−15
10	14	+10	14	15	+ 5	17	14	−15
15	19	+11	19	20	+ 4	22	19	−15
20	25	+12	24	24	+ 3	27	24	−14
25	30	+12	29	29	+ 1	Nov. 1	29	−14
Mar. 1	Sept. 3	+13	July 4	Jan. 2	0	6	May 4	−13
6	8	+14	9	7	− 1	11	9	−12
11	13	+14	14	12	− 3	16	14	−12
16	18	+15	19	16	− 4	21	20	−11
21	23	+15	24	21	− 5	26	25	−10
26	28	+15	29	26	− 6	Dec. 1	30	− 8
31	Oct. 4	+15	Aug. 3	31	− 7	6	June 5	− 7
Apr. 5	9	+15	8	Feb. 4	− 8	11	10	− 6
10	13	+15	13	9	−10	16	15	− 5
15	18	+15	18	14	−10	21	20	− 3
20	23	+15	23	18	−11	26	26	− 2
25	28	+14	28	23	−12	31	July 1	− 1
30	Nov. 2	+14	Sept. 2	28	−13			

and umbrellas to a factory building in the United States leads to definite results in some cases. Suppose that the long dimension of a factory is east and west. To exclude direct sunshine the east and west ends of the building might be windowless, the northern side should have vertical fins and the southern side umbrellas that extended unbroken across the entire length of the wall. Such a system would give a considerable amount of light from the sky at all times of the year. If in addition, the fins and umbrellas were linked together and adjustable, as is sometimes seen in Mexico and Brazil, the entire assembly could be adjusted daily by push button control for optimum glareless daylight illumination.

A large part of the numerical data and curves have been derived for the northern hemisphere, and to avoid confusion, but little mention has been made of the southern hemisphere. The dates given in Table VI allow a transfer from the northern hemisphere to the southern hemisphere, and the corresponding dates indicate days of equal length. Thus February 15 in the southern hemisphere has the same duration of daylight as August 19 in the northern hemisphere, but eleven minutes must be added to the times of sunrise and sunset in the northern hemisphere.

The data are for intervals of 5 days in the first column, but the intervals in the second column vary from four days to six days in order to get the best agreement. If more precise data are required, reference may be had to "Tables of Sunrise and Sunset and Twilight," a supplement to the American Ephemeris, from which Table VI was derived.

In Memoriam

Part V of Mr. Benford's studies on "The Duration and Intensity of Sunshine" is the last of his many notable contributions to the sciences of illuminating engineering and of optics. Mr. Benford, one of the country's leading physicists, died suddenly at his home last December 4, 1948. Though retired last year from the Research Laboratory of the General Electric Company, Schenectady, N. Y., he was at the time of his death actively engaged in several scientific projects, one being the preparation of a book on Radiometry.

Mr. Benford was one of the Society's earliest members, contributing to its *Transactions* much of his work in optical research. His important series on the distribution of sunshine on buildings, of which Part V is herein posthumously presented, is considered, as is other of his work, basic data, designed to enable architects to orient their buildings to give desired conditions of lighting. At the time of his death he had a considerable amount of additional material planned for publication. It is hoped that this will not be lost, but can be given to the world, perhaps with the aid of his former associates.

Telescoping Lamp Posts Used for Paris Bridge

THE LIGHTING of a bridge may be just another lighting job in many instances, but distinctly not so where the bridge happens to be the one which carries the Cour du Carrousel over the River Seine directly in front of the famed Palais du Louvre in Paris. In the belief that many readers of ILLUMINATING ENGINEERING will be interested, a news item prepared by Stephen White appearing in the Paris Edition of the New York *Herald-Tribune* some months ago is quoted here:

"The Pont du Carrousel, like any well-behaved Paris bridge, crosses the Seine, and has been doing so for more than a century.

"It crosses at a rather pleasant place, too, and leads directly into the Louvre. It did not always do exactly that. Before the war the Pont du Carrousel was a few dozen feet down river, and not quite square with the Louvre. But when the growing demands of automobile traffic made it necessary to widen the bridge, the powers-that-be decided, very wisely, that it would look better if it were placed a little more judiciously in respect to the Louvre, and it was rebuilt in accordance with that decision.

"It was the very fact that the bridge was so handsome that created a problem, some ten years ago. If it had been an ugly bridge, there would have been no difficulty. But beauty involves certain responsibilities, to which Paris is always alive.

"For bridges, it goes without saying, must be lighted if they are to function properly. Normally, in Paris as anywhere else, they are lighted by erecting street lights along their length.

"This, no doubt, is no more than fitting for a common bridge. But street lights on the Pont du Carrousel seemed almost an indignity. They would have meant that the Ile de la Cité would be viewed, from downstream, through a picket fence of lamp posts and from upstream the long dominating lines of the Grand Palais would be chopped by the verticals of the posts. This might be very well for New York since no one wants to look at Welfare Island anyway. But Paris is not New York.

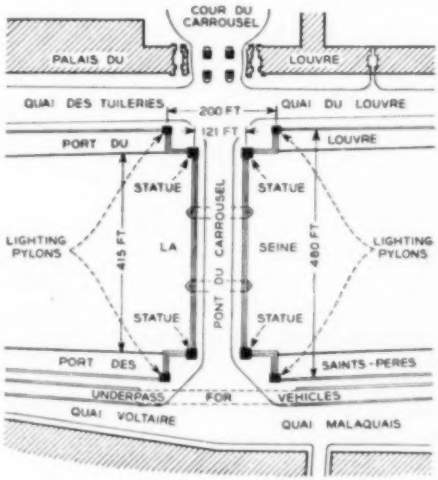
"The alternative immediately offered itself: Lights on either side of the bridge at both its ends. Yet this solution, too, had its flaws. The Seine is no East River, but it is decently wide. To light it from the ends would mean powerful installations. Set low, they would blind the motorist crossing the bridge. Set high — but this prospective indignity demands a paragraph of its own.

"Set high enough to fulfill their functions, the lights would be yards higher than the Louvre. That would mean that the view from the Left Bank would be destroyed. The broad avenue would no longer bring out the beauty of the Louvre — the posts would dominate the lines of the palace, cheapen it, hack away its harmony. Paris will not contemplate such treatment of the Louvre.

"Yet the bridge had to be lighted. The matter was taken under advicement. There was a series of conferences among the Department of Bridges, the Department of Lighting, the Department of Fine Arts, the Committee on Esthetics for the City of Paris, the Committee on the Louvre, the Union of Architects, the Union of Lighting Engineers; about thirty men in all.

"Plans were made, and work was begun. The war came along, and the plans were set aside.

Cross Section of ground plan.



ILLUMINATING ENGINEERING is indebted to I.E.S. Member T. D. Wakefield for bringing this matter to attention, and to I.E.S. Member Jean Chappatt of Paris, France for his assistance in securing additional data.

"All this, of course, is ancient history. But this report is written to make known that as soon as the was ended, the plans were dusted off, the mategial withdrawn from hiding, and the work recommenced. With the result that today the Pont du Carrousel is bare of lamp posts, and the Grand Palais and the Ile de la Cité are undefiled. At Louvre, and the lamps themselves imitate, with out being slavish copies, the towers of the Louvre.

"And when night falls, a 5-horsepower motor in the base of each post goes into action. Noiselessly, the lamp posts lengthen. In a minute or two they have gained twenty feet in height, and when the lights go on, the entire bridge is illuminated without glare. At dawn the motors whir again, and the posts quietly shrink.

"It is true that these telescope lamp posts were rather expensive to build, and that the four motors use more current each night than the lights themselves. On the other hand, Paris has managed to have, all at the same time, the bridge, the illumination, and the beauty.

"Which seems very reasonable."

For the accompanying illustrations and the following additional data, ILLUMINATING ENGINEERING is indebted to Monsieur Andre Herzog, Minister of Public Works, Paris.

"The problem of lighting a big town bridge very often presents an esthetic difficulty. To keep the columns in a good proportion with the bridge roadway would give the common 30-foot mounting height with about 120-foot interval between columns. But, as seen from the embankment and neighboring wharfs, such dimensions are not in good proportion with the while bridge. . . . In the case of the Carrousel bridge, there was the further necessity of harmonizing the designed proportion of the lighting supports to fit in properly with the immediate background of the picture provided by the Louvre Palace.

"The adopted plan provided four columns located as shown in the accompanying sketch, designed to present a day-time height of 48 feet. At night, a telescoping inner section of each column is raised to carry the light to a height of 71 feet so that the light will not dazzle and the ends of the bridge are four lamp posts, discreetly low, so that they blend into the masonry of the Louvre. The columns that make up the lamp posts, forty feet high, are fluted to harmonize with the columns of the that the ground will be uniformly lighted.

"The fixed bottom portion of each column is made up of a square lattice pole surrounded with a sheet iron covered with thin halm-red-copper plates. Each base is provided with four basins in which are mounted reflector units for lighting the column itself when desired. . . . Each lantern is 8 feet high and consists of three lighting elements in each of which is a 750 or 1000-watt lamp and reflector. . . . A 4-kw motor drives a winch which by means of chains, lifts the 2.5-ton mobile part of each column at a speed of 1.5 inches per second, so that the ascent lasts about three minutes. The motor is remotely controled by a musical-frequency signal. The lamps are switched on automatically when the mobile part has reached the high position.

"The present lighting of the Carrousel Bridge was put into commission in June 1947, completing a plan started in 1939. This system has been working these two years without any notable incident."

Telescoping lamp posts on Paris bridge. Daytime view below; night view at right.

Lighting of a Foyer

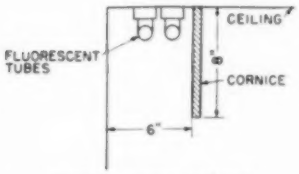
LIGHTING OBJECTIVE: To provide useful illumination for safe seeing conditions and to create striking decorative effects enhancing architectural details and home furnishings.

General Information: The room is long and narrow with three walls painted beige and the fourth wall covered with wallpaper with a silver background an coral and beige figures. The chest is of bleached mahogany and the flanking chairs are covered with coral fabric. The small tables at the windows are made of antique mirror. The draperies are beige satin.

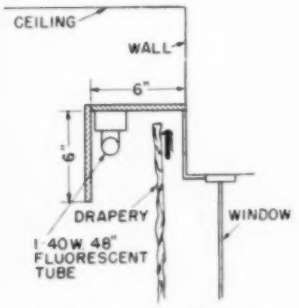
Installation: On the long unbroken wall a wooden cornice extends from wall to wall concealing two rows of 30-watt 3500K fluorescent lamps mounted on the ceiling on wiring channel. The direct light highlights the wallpaper and the indirect light reflected from the side wall illuminates the foyer.

The windows on the opposite wall have lighted window valances each using one 40-watt 3500K fluorescent lamp. The valances are closed at the top, producing down-light to correspond with that of the cornice. Average footcandle value on 30-inch plane is 17.

Interior designed by John Wanamaker, Philadelphia, Pa.; lighting equipment custom-built by the Voigt Company, Philadelphia, Pa.



Detail of Cornice Lighting



Detail of Valance Lighting

Lighting data assembled by the Sub-Committee on Home Lighting Data Sheets to show methods of making light an integral part of room decoration and at the same time serve a functional purpose.

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Brightness *vs.* Area in the Glare Factor Formula

By PHELPS MEAKER

An experiment is described in which two glare sources of different size and brightness were adjusted to produce equal discomfort sensations. If a discomfort glare index is assumed to be directly proportional to source area, then this investigation shows that the index will also vary as the source brightness raised to about the 2.15 power. The author considers this result as support for the continued use of 2 as the exponent of brightness in computing Glare Factors. A tentative scale is appended as a guide to the interpretation of the significance of glare factor values.

THE Glare Factor Method for evaluating discomfort due to direct glare has been described in two previous papers.[1,2] It is generally agreed that sensations of visual discomfort due to bright areas in the field of view depend upon details of the position of the source in the visual field; upon background and adaptation brightnesses; and upon two other factors, namely:

Visual size (solid angle) of the glare source or sources.
Brightness of the glare source.

The glare factor formula includes source size as the base dimension; and the other factors have been given weights according to the best applicable research data, experience and appraisal. In the absence of specific scientific support for all parts of the formula, it was decided to put the method into practice for a trial period. It was hoped that this would reveal any substantial shortcomings in the prediction of levels of comfort or discomfort. This trial period has gone on now for about two years without any cases coming to light which cast serious doubt on the usefulness of the formula as applied in the second paper.[2,3]

There remained one disturbing fact, however. Brightness (squared) is included in the formula; the reason for assigning this particular weight being explained in the first paper.[1] The results obtained by Holladay,[4] using the shock method for evaluating the discomfort from one *intermittently* exposed *fixated* glare source showed brightness effective as the *fourth* power, relative to the effect of solid angle. Before asking for general acceptance of the glare factor formula and concept, it was thought desirable to conduct a further investigation as to the importance of source brightness relative to area where *continuously* exposed, *not fixated*, glare sources are involved.

If there are two sources of glare of different size and different brightness, and each produces the same degree of discomfort or annoyance when viewed under identical conditions, their glare factors, by definition, should be the same.

The glare factor equation contains the product of area and brightness, the latter having an exponent which we will consider to be an unknown. The purpose of the experiment will be to determine the exponent in the equation:

$$A_1 B_1^n = A_2 B_2^n; \text{ or } \frac{A_1}{A_2} = \left(\frac{B_2}{B_1}\right)^n$$

when the globe of area A_1 and brightness B_1 is judged to be as annoying as a globe of area A_2 and brightness B_2.

To make a comparative appraisal of two lighting installations, one might build two adjacent rooms, so that by just turning the head, either could be studied. It would be better yet if it were possible to make an arrangement whereby they could be seen at the same time. If the problem is to compare two single sources, it is quite convenient to have them both in the field of view simultaneously.

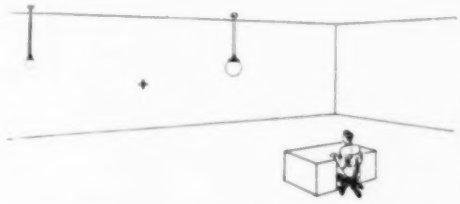


Figure 1. Location of the two glare sources in the observer's field of view. After looking at a magazine lying flat on the table for a while, he was asked to raise his head and look toward the cross. Then he would state which of the globes caused the greater annoyance.

MR. MEAKER is with the Engineering Division of the General Electric Company, Nela Park, Cleveland, Ohio.

This is the method followed, with the arrangement shown in Fig. 1.

The Two Glare Sources

Two completely diffusing glass globes were located ten feet from the subject, approximately 10° above the horizontal, and 25° to right and left of the center. Each one was clearly visible with either eye so there was no need for reversing the globe positions in this informal experiment. The background wall brightness was 18 footlamberts. The back halves of the luminous globes were covered so that when their brightness was changed, there was no effect upon the wall illumination. When the subject looked toward a point midway between the globes, his adaptation would not be affected to any substantial degree by the brightness of sources displaced 25° to the side. Hence, it is believed reasonable to consider that the effect of surroundings was the same for both glare sources, and the only difference was in size and brightness. It must be emphasized that the ability of the subject to perform critical seeing tasks while glare sources are in the field of view is not tested in this experiment. Comfort with relaxed vision is the only criterion.

The smaller source consisted of a white bulb lamp, viewed end on, and made with two filaments so that three ranges of brightness were obtainable. By selection of filaments and variable-voltage combinations of them, it was possible to keep the difference in color between the two glare sources at an amount less than can be discriminated by the ordinary observer.

Globe on Left (Variable Brightness)
Area 11 square inches (A_2)
Brightness 3100 to 14000 footlamberts without noticeable color change (B_2).

Globe on Right (Fixed Brightness)
Area 103 square inches (A_1)
Brightness 1800 footlamberts (B_1)

Under these conditions, the equation written previously becomes:

$$\frac{103}{11} = \left(\frac{B_2}{1800}\right)^n$$

A table showing the relation between a few values of B_2 and n is included in the appendix to this paper.

Appraisals by Observers

The observer was given casual reading material which lay flat upon the table, and it was suggested that from time to time he should raise his head to the horizontal. This would direct his line of sight to a point which was outlined on the wall midway between the two glare sources. After a few seconds, he was asked to state whether the large globe or the small one produced the greater sensation of annoyance or discomfort. The opinions expressed fell into three categories: a definite feeling in favor of one globe or the other, a sensation of equality between them, or a feeling of marginal difference. In the latter case, the subjects were encouraged to discuss their sensations and opinions. As a result, it was usually possible to decide which side of equality was represented by these marginal opinions. These conversations served also as a frequent check to make sure that the criterion was one of comfort, and not an evaluation of brightness or candlepower.

The brightness of the variable source was changed radically for each observation and the point of comparable sensation was approached from both directions. The adjustment from one brightness to the next was made by random steps so the subject could not know whether the next setting was of higher or lower brightness than the one previously shown him.

The expressed opinions of each observer were plotted as illustrated in Fig. 2 for two tests on each of three subjects. In this way, contradictory opinions could be weighted fairly in determining the proper point of crossing the equality line.

Whether the widely divergent data from observer *AL* are included or not, the results come close to confirming the selection of 2 as the ex-

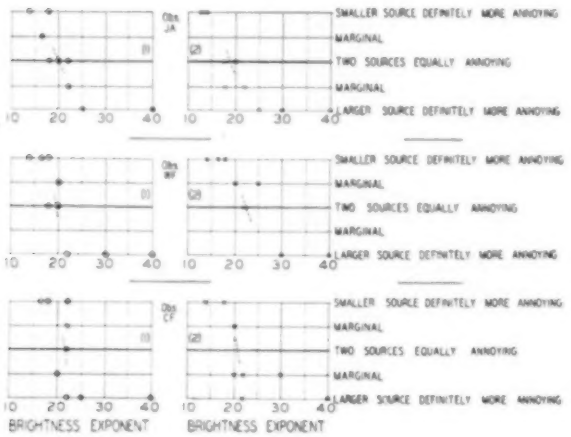


Figure 2. Plots of typical data showing how the point of equal sensation was established for each series of observations. Data labelled (2) were taken on the day following (1). Complete tabulation of data is on page 403.

DATA FROM 14 TESTS ON 10 OBSERVERS

Brightness exponent when scene was appraised as:

Observer	Smaller Globe More Annoying		Equally Annoying	Smaller Globe Less Annoying		Equality Point from Plotted Data (Fig. 2)
	Definitely	Marginal		Marginal	Definitely	
PD	1.4, 1.8	2.0, 2.2, 2.5	.....	2.2	3.0, 4.0	2.2
LO	1.3, 1.4	1.65, 2.0	1.8	1.8, 2.0	2.2, 2.5, 3.0	1.9
JA (1)	1.4, 1.8	1.65	1.8, 2.0, 2.2	2.2	2.5, 4.0	2.0
JA (2)	1.3, 1.4	.....	1.8, 2.0	1.8, 2.2	2.5, 3.0, 4.0	1.9
KG	1.4	1.8, 2.0	2.0	2.0, 2.2, 2.5	3.0, 4.0	2.1
RA	1.4, 1.8	.....	2.0, 2.0	2.2	2.5, 4.0	2.05
WF (1)	1.4, 1.65, 1.8	2.0	1.8, 2.0	.....	2.2, 3.0, 4.0	1.95
WF (2)	1.4, 1.65, 1.8	2.0, 2.5	2.2	.....	3.0, 4.0	2.25
CF (1)	1.65, 1.8, 2.2	2.2	2.2	2.0	2.2, 2.5, 4.0	2.15
CF (2)	1.4, 1.8	2.0	.....	2.0, 2.2, 3.0	2.2, 4.0	2.05
LA	1.4, 1.8	.....	2.0	2.2	3.0, 4.0	2.0
AM	1.65, 1.8	2.2, 2.5, 3.0	2.0	.....	3.0, 4.0	2.3
AL (1)	1.4, 1.8, 2.2	2.0, 2.5, 6.8	3.0, 6.8	4.0	.....	3.1
AL (2)	1.4	1.65, 1.8, 2.5, 3.0	3.0, 4.0, 6.8	6.8, 9.0	9.0	3.5
Average						2.25
Average Omitting Subject AL						2.08

The tests marked (2) were made on the day following (1)

ponent of brightness. For the immediate future, the author plans to continue computations using brightness squared, for it is thought that the convenience is well worth the slight sacrifice in accuracy which may be involved.

There is good support for the assumption that an exponent determined at one brightness is likewise applicable throughout the useful range. The Holladay[5] researches showed one exponent applicable to brightness over the entire range covered, namely, about 75 to 2500 footlamberts. This is an appropriate point to emphasize that the finding of an exponent of brightness of about 2 is not in conflict with Holladay's determination of the fourth power. There is a very real difference in techniques between appraising a single glare source exposed intermittently at the point of fixation; and comparing the sensation of discomfort caused by two steadily burning sources relatively far from the line of sight.

In the present investigation, a considerable range of brightnesses were utilized during the trials of different comparison techniques. Average results showed no strong trend away from the value of 2 as the exponent. In a test with nine subjects where the globe of fixed brightness represented a computed glare factor of about 200 (brightness 2150 footlamberts), the spread of data was from 1.65 to 2.4, averaging 2.08 as the exponent. Where the glare factor was about 80 (brightness 1500 footlamberts), trials with nine subjects and 43 determinations gave widely scattered results but averaged 1.9. A brief trial with two observers at glare factor 20 gave values of 2.1 and 1.6 under conditions of barely noticeable discomfort.

The author extends thanks to Mr. Ward Harrison for his guidance in the conduct of the experiments and the preparation of this paper, and to the observers for their patience.

Appendix

The following table may be of interest to readers who desire an amplification of the significance of the exponent of brightness in equating areas and brightnesses under the conditions of this experiment.

SOLUTIONS OF THE EQUATION TO RELATE AREA AND BRIGHTNESS

$$\frac{A_1}{A_2} = \frac{103}{11} = 9.37 = \left(\frac{B_2}{1800}\right)^n$$

when $A_1 = 103$ sq. in.
$A_2 = 11$ sq. in.
$B_1 = 1800$ ft-L

Value of $\frac{B_2}{B_1}$	Value of $\frac{B_2}{1800}$	Value of $\left(\frac{B}{1800}\right)^n$	Value of n
16.870	9.37	9.37	1.0
7.999	4.44	9.37	1.5
6.239	3.47	9.37	1.8
5.518	3.06	9.37	2.0
4.698	2.61	9.37	2.2
3.794	2.11	9.37	3.0
3.150	1.75	9.37	4.0

An exponent of 1.0 would mean that brightness has no greater effect than area.

Tentative Interpretation Scale

During the course of many discussions of the application of glare factors, people have asked for more specific suggestions on the interpretation of the various steps in the scale of values. The following is offered as an indication of the results of many appraisals in terms of describable comfort and corresponding glare factor steps.

0-10—Not likely to be criticized because of discomfort. Esthetic preference, personal prejudice, and appreciation of form and style may be stronger forces influencing like or dislike.

10-15—Few, if any, people will find such an interior lacking in comfort, unless it is their habit to look upward, toward the luminaires. The value of *15* is the upper limit of what is considered the completely comfortable range for people working in a fixed position for long periods.

15-25—Some people will find such rooms slightly annoying, particularly when they are engaged in critical work for long periods. This range is usually satisfactory where the occupants are changing activities and position at intervals of an hour or so.

25-40—This range should not be exceeded where quality of lighting is a consideration, in rooms where critical work is being done. Such values are illustrated by large rooms indirectly lighted to 75 ft-c or more in which some persons are persistently conscious of the large ceiling area.

For fine bench work in industry, this range may be considered satisfactory assuming that workers are under somewhat less strain of mental concentration than is required in clerical work.

40-100—Industrial (factory) installations considered to be good lighting practice fall in this range, for it is assumed that the average worker is moving about frequently. The more demanding the type of work, the lower the glare factor should be.

Store Lighting and Glare Factors—Stores, depending upon the atmosphere desired and the techniques of lighting employed, will be found representing a very wide range of glare factors. A store interior, however, is usually quite different from the type of environment associated with continued critical visual work. It hardly seems likely that customers who are moving about continually will be made uncomfortable because of the presence of direct glare. Clerks, whose position may, in some few cases, be relatively fixed and who may have to face in certain directions for hours at a time, have made complaints regarding ocular discomfort due to glare.

It seems undesirable to attempt any generalized correlation between glare factors and the suitability of the lighting treatment for merchandising purposes. Some techniques of store lighting such as downlighting with well-shielded units may result in brightly lighted merchandise with very little visible brightness above eye level. The glare factor computation would not evaluate the counter level brightness, which is responsible for the appearance of "life" in the store. In such a case, a low glare factor would not necessarily indicate a subdued atmosphere.

Therefore, it may be better to think of a computed glare factor, not as an index of glare or discomfort in the store, but as a figure describing the sensation of brightness from luminaires above eye level.

The managers of some stores are convinced that brightness of the general lighting fixtures gives the impression of business activity in the store, as does the frequent ringing of loud cash register bells. Where everybody is moving about in a great hurry, this is not such an unreasonable idea. At any rate, if one man likes a store with fixture brightnesses for which the computed glare factor is about 450, it should be possible to tell him whether the lighting planned for another store will produce about that same sensation. It is quite certain that he would not be equally pleased with a glare factor of 50 or 1500!

References

1. Harrison, Ward: "Glare Ratings." ILLUMINATING ENGINEERING, Vol. XL, No. 8, p. 525 (September 1945).
2. Harrison, Ward and Meaker, Phelps: "Further Data on Glare Ratings." ILLUMINATING ENGINEERING, Vol. XLII, No. 2, p. 153 (February 1947).
3. Harrison, Ward and Meaker, Phelps: "Glare Factors and Their Significance," *General Electric Review*, Vol. L, p. 31 (August 1947).
4. Luckiesh, Matthew, and Holladay, L. L.: "Glare and Visibility," *Transactions of the Illuminating Engineering Society*, Vol. XX, No. 3, p. 221 (March 1925).
5. Holladay, L. L.: "The Fundamentals of Glare and Visibility," *Journal Optical Society of America*, Vol. XII, p. 271 (1926).

Luminous Ceiling

Enlarging the entire house optically, and actually adding another room with a dramatic rounded wall, the solarium-bar of the Sylvania Lighting Center was constructed around the framework of an old-fashioned and unattractive porch which leads into the living room. By means of a luminous ceiling, the new room retains its cheerful outdoor effect at night.

Simple, single-lamp lighting fixtures containing 40-w fluorescent tubes are placed end to end around the perimeter of the fan-shaped ceiling and are shielded by ribbed, frosted glass which forms the luminous ceiling. Because the old porch was not

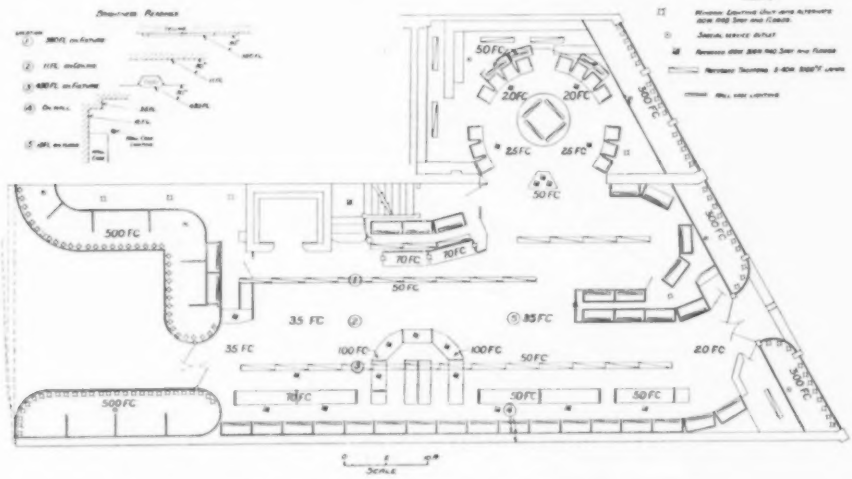
Brightens Solarium

sheathed beneath the rafters, it was easy to install the lighting to the rafters. For a cool effect, standard white color fluorescent lamps were used.

Along one curved wall, dry wall construction replaces pillars, posts and the railing of the original porch around which this room was built. A 20-w fluorescent lamp is attached to the back wall of the cabinet which serves as a bar. This lighting not only illuminates the inside of the cabinet but shines through the top to highlight glasses and other accessories placed on the surface.—Photo courtesy of Sylvania Electric Products Inc.

Lighting a Men's Shop

LIGHTING OBJECTIVE: To illuminate a men's shop to provide an attractive atmosphere and to highlight the merchandise for appraisal.



Installation at Wells and Coverly Men's Shop, Troy, New York.

General Information: Area to be lighted is an irregularly shaped store (see plan) almost entirely surrounded by wall cases and displays. Ceiling is a light-colored acoustic tile.

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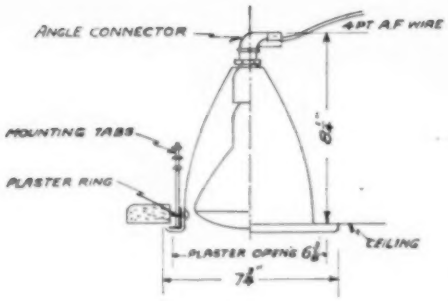
(over)



Installation: The general illumination is provided by 3500K fluorescent lamps installed in three-lamp 40-watt recessed troffer units with satin glass covers manufactured by the Hi-light Company, Jersey City, New Jersey.

The show windows are lighted by Gruber Brothers' 150-watt R40 spot and floodlight units spaced alternately. The incandescent down lighting in the interior as shown on the plan is a Gruber Brothers' Catalog No. 150 downlight.

Footcandle values taken approximately one year after installation are indicated on the plan. Brightness readings for the stations indicated are tabulated above and to the left of the plan.

Lighting data submitted by C. D. Hollister, New York Power and Light Corp., Albany, New York, as an illustration of good practice and to aid in the design of similar installations.

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Lighting by Prescription

By L. C. BUTLER

WHY should so-called tailor-made or "Prescribed Lighting" be more economical from the long range point of view than the typical run of mill lighting installation? Answers may be found in facts brought to light, through research in the science of seeing, which indicate the effects, both local (in the eye) and on the human system, *in toto*, produced by inadequacies in lighting, while the demands on our eyes are increasingly acute in the daily routine of our activities. These researches denote the need for recognition by the lighting specialist, not only of the more obvious problems to be solved in planning the lighting system but of all factors, seen and unseen, that may be involved and, if not taken into account, may detract from the overall efficiency of the illumination. These factors may be outlined as follows:

1. Design, appearance, efficiency, general adaptability of the lighting system.
2. Brightness ratios produced by the illumination.
3. Color temperature of the light.
4. Specular reflection produced by the illumination.
5. Glare factor.
6. Footcandle adequacy of the illumination for the seeing tasks.
7. General visibility.
8. Need of provision for ease in seeing where prolonged seeing is necessary.
9. Whether the illumination is so planned as to save the eyes needless fatigue and the risk of physiological complications, in whatever tasks they may have to perform.
10. Possible psychological effects of the illumination.

One of the oversights common in planning illumination has been that we in the lighting profession work, at best, primarily if not exclusively, with the mechanics of lighting and give little or no thought to the eye or optical mechanism that has to put up with the illumination, because we are averse to delving into what we are pleased to call psychological and physiological abstractions.

So-called psychological and physiological aspects of the science of seeing are not imponderables nor abstract considerations. On the contrary, they are primal factors in this science, for they embrace, respectively, such important considerations as "Conscious Reaction" to the effects of the illumination, including its influence upon the appearance of persons and things, *i.e.*, whether the illumination will have a favorable effect, generally, on colors, objects, and the complexion; whether the light will render their natural lustre and color values to objects and materials or distort colors and give them a more or less lack-lustre and dull appearance, which is said to be the tendency of fluorescent lighting, *per se*, regardless of its rated color temperature. Or when it is not supplemented by incandescent light. Or whether the illumination will be not only of adequate general intensity but also suitable for the seeing tasks involved and designed to minimize eyestrain hazards in the performance of the more critical of the seeing tasks required.

These are basic considerations in planning prescribed lighting and they are governed by:

(a) Quality of the illumination — its appearance, efficiency, suitability in spectral composition, etc.

(b) The general adequacy of the illumination for possible prolonged seeing of the details entailed in the seeing tasks.

(c) Consideration of the eyes — proper shielding of glaring light sources, limiting brightness ratios to prescribed comfort ratings (Refer IES Lighting Handbook).

It has been the general opinion, of the layman at least, that so-called reasonable footcandle levels of illumination, with consistent control of distribution and glare, are the only prerequisites to a good

Fluorescent recessed unit designed to meet engineering specifications. Gimbel ring in center provides either spotlight for accent lighting or floodlight for the two-source color correction.

MR. BUTLER is Vice-President and Sales Manager of the Fullerton Manufacturing Corp., South Norwalk, Conn.

lighting system. It is axiomatic that these are major attributes of well planned illumination, but it is necessary that we predetermine, when prescribing illumination, what will be reasonable footcandles and all-round adequate illumination for the seeing work to be performed and for a generally desirable effect. As the footcandle is a quantitative and not a qualitative unit of light measurement, footcandle requirements may vary somewhat with the wavelength frequencies. For example, the visual curve indicates that light comprised of radiations within the wavelength range of 5500 to 6000 A° produces the highest visual acuity but, being monochromatic in the yellow wavelength band, this light would badly distort colors and would not be acceptable for general use.

Because of the variable factors involved in the visual function, such as the imminent differences in the seeing abilities of individuals — the differences in their eyes, intellect, health, in other words, their visual acuity, the differences in the sharpness and duration of seeing tasks, *it is apparent that neither norms nor the light meter as such are conclusive indices to the ultimate in lighting practice.* The indicia deduced from these empirical methods should, therefore, be considered relative rather than absolute in arriving at a conclusion as to the proper solution of the lighting problem. This does not imply that the lighting specialist should attempt to determine what these differences in seeing ability may be, but rather that he should take into account, in analyzing the lighting problem, particularly the factory, office, and school lighting problem, the fact that these factors are present and must be considered in his calculations.

What may appear to be acceptable footcandle levels when the light source is incandescent would probably be rejected as inadequate levels when the light source is fluorescent, due to the different natures and spectral qualities of these light media. Fluorescent light, regardless of its rated Kelvin temperature, is always deficient in red or the long wavelengths of the visible spectrum, which conversely predominate in incandescent light, and because this is so, fluorescent light produces less specular reflectance and, consequently, less apparent lustre than incandescent light. For these reasons it is, in some instances, considered necessary to blend incandescent and fluorescent light and this combination is usually advocated for selling spaces such as in department stores, ready-to-wear, and specialty shops, and other areas where it is important to maintain as nearly as possible normal daylight color values.

It is a psycho-physiological axiom that the function of seeing is mentally directed and that either voluntarily or involuntarily we compel our eyes to perform the seeing task even when visibility conditions are below required standards and, in doing so, we are apt to strain our eyes, particularly if critical seeing is involved. Even from a practical point of view, prescribed lighting is economical lighting, for it is axiomatic that when the illumination is inadequate for the seeing task or the contrast low, the muscles that control the eye are impelled to vainly "hunt" in accommodating the eye to a focus that will produce as clear an image as possible on the retina and this over-activity causes muscular fatigue which not only results in what is known as eyestrain, but is also communicated through certain motor and sensory nerves throughout the entire nervous system, producing a condition of general nervous fatigue and slowing down the motor reflexes.

Paradoxically, it is the faculty of accommodation with its adaptability to near and distant vision, sometimes called focusing power, and without which our ability to see under varied conditions would be greatly curtailed, that makes it so easy to strain our eyes, particularly if we read or force our eyes to perform any other kind of prolonged critical work without properly prescribed lighting.

Because we may be able to see with the light available does not necessarily mean that the illumination is adequate for the purpose. The fact that the need for glasses to aid vision is much more prevalent among indoor workers than among outdoor workers is indicative of the need for a better understanding by all factions of the lighting industry of the various factors, seen and unseen, which govern lighting needs and prove that the conclusions herein set forth are predicated upon something more definite than theory alone. The foregoing are some of the reasons why a thorough examination of all of the attending conditions should be made when prescribing lighting.

The following statistics denote percentages of ocular defects that obtain in different occupational groups and substantiate our claim that prescribed lighting not only conserves eyesight and human resources, but that by doing this it sustains individual work-hour efficiency and the potential in useful work-hour output per dollar unit cost. As above indicated, the lowest per capita rate of deficient eyesight obtains in the farm-labor or outdoors groups of workers, wherein defective vision varies from 1 to 20 per cent; defective eyesight rises to an average of 50 per cent in the machinist group and as high as 90 per cent in the draftsmen-stenographic groups.

Research reveals that 28 per cent less energy is expended in the process of seeing when the illu-

mination is increased from liminal seeing needs to adequate lighting for the seeing tasks.

The average visual acuity of persons having defective vision is increased as much as 33 per cent when the illumination is made adequate for the seeing task. *High levels of illumination tend to magnify small details, emphasize contrast and lessen color distortion.*

Figuratively, when lighting intensities are high the eyes take snapshots and when the illumination or contrast is low, they take time exposures because of the necessity to "hunt" a focus, as above explained, thereby slowing down the interpretative process, or what is known as cognitive visual reaction time; the lag in the reflexes that follows slows down the worker, reducing his efficiency below normal. Incipient eyestrain invariably accompanies this condition which, if not remedied, can do permanent damage to the eyes.

Paraphrasing excerpts contained in the paper* read by Dr. Matthew Luckiesh, Director of Lighting Research, General Electric Company, before the 1948 Convention of the Illuminating Engineering Society, and which is apropos of the need for a thorough analysis of every lighting problem — "Ease in seeing is equally as important as acute visibility of critical details in the actual performance of prolonged critical seeing. . . . Nervous muscular tension in the eyes is manifested in some measurable degree in the heart beat, the rate of involuntary blinking, and in general bodily and mental fatigue. . . . *It appears axiomatic that when visibility is low, prolonged seeing results in greater waste of human resources than when visibility is high. . . . Certainly one of the major objectives of a science of lighting is to specify footcandles to fit the task.*"

The following observations by other outstanding authorities on light and the human eye provide further affirmation of the need for the application of scientific methods in determining lighting standards for seeing needs:

Doctor Walter B. Lancaster, Ophthalmologist —

What form does discomfort take when the eyes are made to work under unfavorable illumination? The symptoms are both local and general. The local signs are redness, sensations of heat, dryness, scratchiness, and sometimes photophobia (aversion to light), all due to or characterized by an excess of blood to the eye-ball and its lids, the medical term for which is hyperaemia. These feelings cause increased winking automatically, since winking is a protective reflex, feelings of fatigue, aching, pulling sensations are described. The general symptoms are headache, restlessness, irritability, and sometimes sleepiness and the like. *Conspicuous in some cases is an increase in mistakes and the whole picture merges into one of inefficiency and of eye strain.* In brief, it may be stated that the amount of light required depends (a) On the eyes, because if the eyes are deficient they require more light. (b) On the work, for when the work is finer or contrast less, more light is needed.

Doctors C. E. Feree and Gertrude Rand:

Eye-strain leads to rapid fatigue and exhaustion, exaggerates abnormal tendencies in the eye and leads, sympathetically, to functional disturbances in other parts of the body.

Doctor George Wald of Harvard University:

During the war it was often found that men whose vision was of equal strength in normal bright light differed as much as ten times in their ability to see in weak, unfavorable light.

Only the scientist, seasoned lighting engineer, and eye-sight specialist can realize fully how detrimental poorly conceived illumination can really be and fully comprehend that eyestrain often extends beyond the optical organism itself, affecting the coordination of those impulses which control the muscles of the body.

In his lighting recommendations the lighting specialist should give due consideration to the fact that footcandle requirements not only vary according to surroundings, the seeing task and, to a degree, to the spectral characteristics of the light, but also according as the eyes performing the task vary; weak or defective eyes requiring better general visibility and more footcandles than strong eyes for identical seeing tasks. It should therefore be the practice of the lighting specialist:

1. To ascertain the character of the work to be performed; to apply standard formulae for optimum seeing conditions for this kind of work, and also to make reasonable provision in his calculations for possible visual deficiencies and for prolonged seeing, should the latter be involved. This is sound practice and precludes a risk of under-estimating the requirements.
2. To recommend combination fluorescent-incandescent lighting when it is desirable to minimize color discrepancies or because of other psychological considerations.
3. To provide for accent lighting in selling areas, etc., to give proper emphasis to displays.
4. To design as unobtrusive lighting as may be consistent with the conditions and requirements.
5. To provide for the control of objectionable glare.
6. To provide at least 45 degree shielding from exposed light sources when possible.

In the practice of his profession the lighting specialist may encounter many obstacles to the accomplishment of all of these objectives, but the more assiduously he adheres to and promotes the principle of "Lighting by Prescription," the more general will be the recognition and prestige accorded his profession and the greater his contribution to the public welfare and lighting industry.

*Luckiesh, M.: "Important Concepts Underlying Lighting for Critical Seeing." ILLUMINATING ENGINEERING, Vol. XLIV, No. 4, p. 226, (April 1949).

The I.E.S. Guides to Testing Procedures

Prepared by the Committee on Testing Procedures for Illumination Characteristics

PREFACE

The five testing guides presented herewith represent three years' work by the Committee on Testing Procedures for Illumination Characteristics. The scope of these guides is not to set up requirements but rather to get agreement on important aspects of test procedure allowing several methods when possible; to require reasonable but not absolute accuracy; to recommend a procedure where agreement can be reached; to cover "standard" work but to permit variations at the user's discretion. The Committee feels that the Testing Guides should have a minimum of definite requirements. A definite specific requirement tends to retard or stifle the development of new and improved methods. Any departure from a specified method makes it appear that the testing laboratory is not performing the test in a proper manner whereas the method used might be an improvement over the required one. The Guides are intended to outline a path or paths which will lead to the desired goal of adequate results presented in a useful manner and at the same time point out the pitfalls and dangers to be avoided along the way.

The Committee has inspected eight major photometric laboratories in order to get a first-hand conception of general current practice in photometry. These Guides have been subjected to close review and criticism by many of the leading photometric test engineers in the U.S.A. and no effort has been spared to make them both authentic and practical. Every effort has been put forward to encourage uniformity in obtaining sound engineering data on lamps and lighting equipment.

It is axiomatic that no I.E.S. Guide is of any value unless it is generally accepted by and used by the lighting profession and the lighting industry. The procedures recommended should be put to immediate use and become in practice, as well as in theory, part of the established engineering data sponsored by the I.E.S. and generally accepted by the membership and the industry.

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I.E.S. Guide for Electrical Measurements of Fluorescent Lamps — 1948

1. General

(a) In most instances where tests or measurements are made in order to determine the operating characteristics of a device, it is desirable to conduct such tests or measurements under conditions which not only would make duplication of results possible but would give correct answers. This is especially true in the case of lamps where it is desirable to designate certain lamps as standard lamps and to be able to rely on these lamps to repeat themselves in electric and photometric performance. Other lamps may be studied for the purpose of determining rates of deterioration, efficiencies of reflectors and fixtures, etc., where it is necessary to know that results are a true picture of the characteristic under study and not subject to variations caused by failure of a lamp to repeat its performance, even though the desired variations were not imposed. A similar and equally serious condition may exist in cases where auxiliary electrical equipments are measured in terms of lamp performance.

(b) This condition has been especially serious in the case of the hot cathode fluorescent lamp. These lamps, in most cases, have been provided with four contact pins, two of which are used only in the starting circuit and the other two in the operating circuit, but there has been no general agreement as to which two should be used. The particular pair of pins chosen for the operating circuit becomes important because this choice will determine from what regions on the cathodes the arc will strike and this in turn determines the performance of the lamp as an electric circuit. This is only the beginning of a listing of the conditions that will affect the operation and performance of these and other types of fluorescent lamps. Because of this condition this report has been prepared in order to provide a guide for the handling, operation, and testing of fluorescent lamps and their auxiliary equipment in order that variables might be controlled and a reasonable certainty of reproducibility established. The following recommendations should make for comparability of test results between various laboratories and should facilitate interchecks between various interested groups, *i.e.*, standardized or calibrated lamps and auxiliaries should then be

fully interchangeable between the various testing and research laboratories.

2. Lamp Connections — (where applicable)—The lamp position in the test circuit should be fixed with respect to the manufacturers' label or to a pair of test marks placed upon the bases of the lamp to distinguish the pins used for power connections from those used for starter connections. Either the crossover or parallel scheme of pin connections may be used but the adopted scheme should be followed consistently in all measurements and aging of a lamp. The relation of the lamp label and test marks to the circuit connections will be shown on the diagram of the standard test circuit. (See Appendix A.) All starting devices should be disconnected while measurements are being taken.

3. Ambient Temperature—The room in which tests are performed should be maintained at a constant temperature of 80°F. If the ambient temperature varies from 80°F by more than 1°, it should be so stated in the test report. If corrections are applied for temperature variations, the correction factor should be stated in the test report. The room in which tests are performed should be free from drafts.

4. Ballasts—Readings should be taken while lamps are operating in series with a linear reactor delivering rated current to the lamp or while operating in series with a standard reactor supplied with its rated line voltage.

5. Instruments in the Electric Circuit

(a) The potential coils of all instruments should be of the high impedance type measuring rms (root mean square) values. The error of any meter should not exceed one per cent of full scale value after calibration. The potential coils shall have a maximum high impedance with reliability (*i.e.*, which draws not more than three per cent of rated lamp current). In using meters with high impedance potential coils (current less than one per cent) and with the potential held constant, no correction for loss in the potential coil is necessary.

(b) The live pins should be used for voltage connections.

(c) No electrical instruments are to be in the lamp circuit during the period of photometric measurements. See **(e)**.

(d) For the purpose of cutting the electrical instruments into and out of the circuit, a properly maintained switch with a by-pass lead at the hinged end is recommended.

(e) Except for those instrument elements used as a part of the ballasting impedance only one instrument at a time should be connected in the lamp circuit.

(f) The potential element of the wattmeter should always be so connected that the meter measures the loss in this element.

(g) The maximum impedance of the ammeter and wattmeter current coil should be such as to produce a drop of less than two per cent of lamp volts. Correction or compensation for potential drops in the series elements of the ammeter and wattmeter current coils should be made if they are greater than ½ per cent of lamp volts. (These restrictions do not apply if compensation for instruments is included in a variable reactor impedance.)

(h) To be free from wave form errors, it is recommended that voltmeters for measurement of lamp voltage be selected in the following preferred order:

(1) Thermal
(2) Electrostatic
(3) Dynamometer
(4) Iron Vane.

Use of amplifiers with voltmeters and wattmeter potential coils may be permitted if no wave form distortion is introduced and if overall accuracy of amplifier and meter is within above stated maximum permissible limit of error.

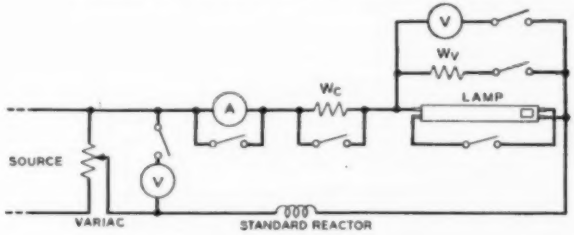
(i) The supply shall be a substantially true sine wave source. The crest factor shall not deviate from 1.414 by more than 2 per cent under any measurement condition.

(j) A recommended standard circuit is shown in Appendix A.

6. Lamp Stabilization — When measurements are made, lamps should be burned until they reach equilibrium and readings made promptly to avoid change of ambient temperature. (Approximately 10 minutes heating time should be allowed for a 40-watt lamp under normal operating conditions.)

7. Photometric Measurements—(See I.E.S. Guide for Photometric Testing of Fluorescent Lamps, 1948.)

APPENDIX A — DIAGRAM OF STANDARD TEST CIRCUIT



I.E.S. Guide for Life Performance Testing of Fluorescent Lamp — 1948

1. Objective—To provide a guide by which fluorescent lamps of standard types may be operated under controlled conditions to obtain an indication of performance as to (1) average life (2) depreciation of light output with use, or both, for the lamp type under test.

2. Selection of Lamps

(a) The lamps selected for test should be truly representative of the group. The degree to which the test samples represent the group affects the value of the test results.

Since life tests are performed on only a very small portion of the total product, the results obtained can serve only as an indication of average performance of the entire product. The value of the test will depend upon the method of sampling, conditions of testing, size of sample and many other factors. The effects of such variables are discussed in the "Manual for Presentation of Data"

TABLE I—Life Tolerances[1]

Number of Lamps Averaged	Allowable Per cent Variation from Rated Life
250 and above	5
249-100	6
99-55	7
54-35	8
44-35	9
34-30	10
29-25	11
24-20	12
19-18	13
17-16	14
15-14	15
13-12	16
11	17
10	18

[1]On account of the natural and inherent variations in individual lamp performance, the average test results of a small number of test samples cannot be depended upon to indicate exactly the average for the larger quantity from which the test samples were taken. The tables of allowable variations are devised in accordance with the observed accuracy of lamp-testing methods and the observed variations in lamp performance.

published by the American Society for Testing Materials.

(b) Table I gives an indication of the effect of one variable, size of sample, and shows the importance of testing large numbers of lamps. This table of life tolerance and its footnote are from the U. S. Treasury Department, Procurement Division, Specification No. 570, which describes an acceptance test for fluorescent lamps.

3. Electrical Supply

3.1—Primary Voltage—Ballasts should be operated at their rated primary voltage and frequency. If the voltage rating is a range, the center rated voltage should be used.

3.2—Line Voltage Wave Form—The crest factor of the voltage wave should not deviate from 1.414 by more than three per cent. Deviation from sinusoidal wave form or the presence of excessive harmonics may have serious effect on lamp performance and should be avoided.

3.3—Regulation of Line Voltage—Line voltage should be as well regulated as possible. In no case should the voltage deviate by more than plus or minus two per cent from the rated value.

4 Operating Conditions

4.1—Operating Cycle—To approximate average conditions of use and to provide a common basis for checking test results, it is recommended that the following cycles be followed. (Operating cycle should always be specified in reporting test results.)

4.1.1—*Basic Cycle*—Three hours operation per start with a minimum 20-minute-off period.

4.1.2—*Supplementary Cycles*—Six or 12 hours operation per start with a minimum 20-minute-off period.

4.2—Method of Starting

4.2.1—*Instant Start Lamps*—All lamps should be supplied with the rated starting voltage as indicated by the lamp manufacturers. Lamps that fail to start should be removed from the test.

4.2.2—*Preheat Start Lamps*—Either mechanical switches or commercial automatic starters may be used. Preheat time should conform to Federal Specification W-L-131 (and current supplement) for Lamp Auxiliaries; Fluorescent.

4.3—Ballast Equipment for Multiple Operation

4.3.1—*Two-lamp Operation*—Lamps of the sizes listed below should be tested on selected two-lamp lead-lag commercial ballasts, one-half of the lamps on the lag circuit and one-half on the lead circuit. Each ballast should operate two lamps; in the event of failure of one of the lamps a replacement lamp should be installed but the performance of the replacement lamp should not be included in the test results.

Lamp connections during life testing should be made in the same manner as for lamp rating testing.

Preheat Hot Cathode Fluorescent Lamps	Instant-Start Hot Cathode Fluorescent Lamps	Cold Cathode Fluorescent Lamps
30WT8	42T6	7′ 9″—25 mm
40WT12	64T6	
40WT17	72T8	7′ 9″—20 mm
100WT17	96T8	

4.3.2—*Single Lamp Operation*—Lamps of the following sizes may be operated on single-lamp lag commercial ballasts:

Preheat Hot Cathode Fluorescent Lamps
15T8
15T12
20T12

4.3.3—*Selection of Ballasts*—Ballasts used for life testing should be selected in accordance with Federal Specification W-L-131 (and current supplements) for Lamp Auxiliaries; Fluorescent, except that the wattage delivered to the lamps should fall within the limits given in Table II and the ratio of crest to rms lamp current should exceed 1.6.

4.4—Vibration and Shock—Lamps should not be subjected to excessive vibration or shock during life testing.

4.5—Ambient Temperature—Life tests should be conducted indoors under usual room temperature conditions. Excesses in room temperature should be avoided and the room should be free from drafts.

4.6—Maintenance of Life Tests—It is recommended that the life test racks be patrolled several times a day to check for lamp failures. It is further recommended that ballasts and starters be periodically checked to assure that they remain within specification limits.

TABLE II—Wattage Delivered to Lamp

Per cent of Rated Primary Volts	Wattage delivered to a Reference Lamp.* (In per cent of wattage delivered to same lamp by a Standard Reactor**)
100	96 to 104 per cent
110	Not more than 113 per cent

*A Reference Lamp is one whose electrical values are close to the rated values when measured on a standard reactor.

**A Standard Reactor is one which operates a reference lamp at values close to the lamp's rating. (See Federal Specification W-L-131 and current supplement for typical specification of standard reactors.)

5. Photometric and Electrical Measurements

5.1—Rating Periods—For their initial lumen output, lamps should be photometered after 100 hours of life test operation. If lumen maintenance is to be reported, the lamps should also be measured after at least two additional intervals; preferably at approximately 20 and 70 per cent of rated life.

5.2—Method of Measurement—All measurements should be made in accordance with I.E.S. Guide for Electrical Measurement of Fluorescent Lamps and I.E.S. Guide for the Photometric Testing of Fluorescent Lamps. In order to indicate proper lamp operation and to determine lumen per watt values, electrical measurements should be reported for each photometric interval.

6. Evaluation of Test Results

6.1—GENERAL — Reported data should be based on the performance of the total number of lamps used at the start of the test. Data on lamps that fail prematurely, lamps of poor light output and lamps of poor electrical characteristics should be included in reporting results. End of life of each lamp should be recorded.

6.2—TEST REPORTS—The Test Reports should include the following data:

Number of lamps tested
Description of lamp type
Operating cycle
Description of auxiliary equipment and starting method
Total hours operated
Life of each lamp that failed
Intervals of measurement
Number of lamps measured at each interval
Methods used in taking electrical and photometric measurements
Average lamp life (when applicable)
Average lumen maintenance at each test interval (when applicable)
Any unusual conditions observed in operation, testing or performance.

I.E.S. Guide for the Photometric Testing of Fluorescent Luminaires — 1948

1. Objective—To provide a guide that will promote uniform test results in determining and reporting the illumination characteristics of fluorescent luminaires. The characteristics are described in accordance with the type of lighting used.

1.1—GENERAL LIGHTING CHARACTERISTICS—To provide data particularly useful for evaluating luminaires used for general lighting purposes, the illumination characteristics are described in terms of candlepower distribution and brightness of the luminaire.

1.2—LOCALIZED LIGHTING CHARACTERISTICS—To provide data particularly useful for evaluating luminaires used for localized lighting purposes, the illumination characteristics are described in terms of illumination in footcandles developed on a plane surface at a specified distance from and in a specified relationship to the luminaire and the brightness of the luminaire.

2. Selection of Luminaires — Luminaires selected for test should be representative of the manufacturers' regular product. Lamp ballasts regularly furnished as part of the luminaire or recommended for use with the luminaire should be used to operate the test lamps during the test.

3. Electrical Supply

3.1—PRIMARY VOLTAGE — Ballasts should be operated at their rated primary voltage and frequency. If the voltage rating is a range, the center rated voltage should be used.

3.2—REGULATION OF LINE VOLTAGE —The supply should not vary more than $\pm 1/2$ per cent in voltage during the test.

4. Test Apparatus

4.1—TEST LAMPS — Test lamps should be constant in light output for constant line voltage and repeated operation. A minimum seasoning period of 200 hours is recommended. White lamps should be used unless otherwise specified. In multiple lamp luminaires, the test lamps should be matched in light output within ±5 per cent when measured on the same circuit. Lamps should be selected for uniform brightness and color from end to end and around long axis. Striped lamps should be oriented to provide minimum interference.

4.2—PHOTOMETRIC EQUIPMENT

4.2.1—*Candlepower Distribution General Lighting* — The photometric equipment should be calibrated throughout the entire usable scale so that its individual readings can be reproduced within a tolerance of ±2 per cent. Provisions should be made for correct optical positioning of the luminaires in relation to the photometric axis and for candlepower measurement at any angular setting in both horizontal and vertical directions. Provisions should be made for eliminating extraneous light.

4.2.2—*Illumination in Footcandles Localized Lighting* — The photometric equipment should be calibrated throughout the entire usable scale so that its individual readings can be reproduced within a tolerance of ±2 per cent. The instrument should be substantially cosine-corrected. Provisions should be made for eliminating extraneous light.

4.3—ELECTRICAL INSTRUMENTS—The instruments should have good reproducibility of indication and large scale deflection for the conditions under which they are used. Each meter should be free from frictional and/or heating errors.

5. General Test Conditions — The luminaires should be operated under conditions as nearly typical of end-use as possible or suitable corrections should be made.[1,2,3] Lamp circuit pin connections should remain the same throughout the test.[2] The ambient temperature should be kept constant, preferably between 75 and 85 degrees F in the vicinity of the luminaire. Drafts should be avoided. Lamps and ballasts should reach stable operating conditions, particularly as to temperature, before tests are made. Unnecessary restarting of lamps during the test should be avoided.

6. Test Procedure—General Lighting Characteristics

6.1—TEST DISTANCE[2]—Test distance should be sufficient to give representative candlepower measurement, preferably at least five times the maximum luminaire dimension. The photometric test distance is defined as the distance from the center of the lamps to the surface of the test plate or photo-sensitive element. With luminaires in which the lamps do not all lie in the same plane, the test distance should be measured to the geometric light center position.

6.2—CALIBRATION OF PHOTOMETER—Calibration is necessary to relate the light output of the test lamps operated in the luminaire to the lamp manufacturer's rating and to establish luminaire efficiency.

The calibration may be made by measuring the normal (90 degrees) candlepower of the test lamps operated outside the luminaire and assigning to that reading the calculated value that would result if the lamps being measured were delivering rated lumen output. All subsequent readings of luminaire candlepower are

then directly proportional to this normal candlepower reading.

When establishing the calibration, the following conditions should be observed:

a. Lamps should be mounted in open air outside the luminaire, preferably in a horizontal position, and their position should be normal (90 degrees) in relation to the photometer, test plate or light sensitive surface. A supporting structure should be designed and used to avoid changing lamp temperature. Reflecting surfaces should be avoided.

b. Electrical conditions and instruments and test distance should be the same as for the luminaire test.

c. Lamps should be operated on the same circuits of the same ballasts used in the luminaire tests. All lamps should be operating during period of calibration.

d. When testing more than one lamp, lamps may be photometered singly, averaging their readings, or in a group. If measured in a group they should be mounted so as to prevent interreflections between lamps and mutual heating effects.[2]

e. Lamps and ballasts should reach stable operating conditions before readings are taken.

f. The normal (90 degrees) candlepower measured under these conditions should be assigned a value equal to the normal candlepower that would result if the lamps were delivering rated lumens. The formula:

$$\frac{\text{Rated Lamp Lumens}}{9.25} = 90^\circ \text{ cp}$$

may be used to establish the rated lumen/normal candlepower relationship.[1]

Having thus established the ratio between candlepower and one reading point, all other readings may be expressed in candlepower by applying the same ratio.

6.3—Luminaire Candlepower Measurements

6.3.1—*Mounting* — A suspended luminaire should be mounted on a frame which will interfere the least with any upward light.[2, 3] A surface mounted luminaire may be mounted to simulate* end-use conditions.[2, 3]

6.3.2—*Readings* — Photometric readings should be taken with the luminaire in its normal end-use position or provisions made to correct readings taken in any other position to those which would have been obtained in the normal position. The effect of temperature changes on light output due to departure from normal position makes these corrections necessary.[1, 2, 3]

6.3.3—*Angles for Measurement*

6.3.3.1—*Points*—The number of points measured photometrically in various vertical planes and the angular spacing between points should be such as to permit plotting of well-determined candlepower distribution curves. Steps of 10-degree intervals in a vertical plane are usually satisfactory. Shorter intervals are recommended where the distribution curve is changing rapidly or is irregular in form.

6.3.3.2—*Planes*[1, 2] — The number of planes explored should be determined by the nature of the distribution as to symmetry or irregularity and the end results desired from the test. Planes are recommended through at least three positions; namely, parallel with lamp axis, 90 degrees with lamp axis and 45 degrees with lamp axis. In the case of decidedly asymmetric distribution five planes may be necessary to obtain representative results. (Additional planes at $22\frac{1}{2}$ degrees and $67\frac{1}{2}$ degrees with lamp axis.) The number of vertical planes measured should be stated in the test report. Candlepower distribution curves should be plotted on the test report sheet and clearly labeled.

6.4—Brightness Measurements[4]

6.4.1—*General* — Measurements should be made of the average brightness of a one-inch square or of one square inch rectangular area with the major dimension selected to suit the particular area being measured but not exceeding four inches. The method and area measured should be stated.

6.4.2—*Instrument Calibration* — The instrument should be calibrated from the test lamps during their photometric calibration using the manufacturers' published bare lamp brightness data. As noted earlier, precautions should be taken to prevent interreflections between lamps or temperature changes during calibration.

6.4.3—*Angles of Measurement* — The maximum brightness of the luminaire (taken according to **6.4.1**) should be measured both perpendicular and parallel to line of tubes in the following zones[5, 6] from nadir*: 0° to 45°, 45° to 60°, 60° to 70° and 75° to 90°. Additional measurements (both maximum and minimum) may also be necessary to adequately determine the performance of the unit. If maximum brightness occurs on the simulated ceiling (where used), it should be measured as above.

6.5—Computation of Candlepower Distribution Test Results

6.5.1—*Computing Candlepower*— The photometric readings should be converted into candlepower based on lamps delivering rated lumens by applying the factor developed by calibration of the photometer and test lamps so that points for the candlepower distribution curves may be established and subsequent calculation of zonal lumens and luminous efficiency can be made.

6.5.2—*Computing Zonal Lumens*— Zonal lumens may be established for each zone by averaging the candlepower values found in each of the planes of measurement and multiplying by the appropriate zonal lumens constant from Appendix A.

6.5.3—*Luminaire Efficiency* — Luminaire efficiency may be computed by dividing the total zonal lumens by the rated lumen output of the lamps.

6.5.4—*I.C.I. Classification*—I.C.I. classification of luminaire light distribution[5, 6] may be established by computing the ratio of upward and downward lumen output to total luminaire lumen output.

6.5.5—*Coefficient of Utilization*— Coefficient of utilization may be calculated from the proportions of upward and downward light output and the degree of concentration in the 0° to 40° zone.[7]

*For a surface mounted luminaire, one common procedure is to construct a simulated ceiling of the same dimensions as the plane projection of the luminaire. The reflectancy of the substitute ceiling should be approximately 80 per cent.[2]

*Common practice is to scan the luminaire from side to side and moving up or down with the instrument aimed at a specified angle.

7 Test Procedure—Localized Lighting Characteristics

7.1—Calibration of the Portable Photometer — As in the General Lighting Characteristics procedure, the photometer may be calibrated with the test lamp or lamps without regard to their true lumen output

The method of calibration is the same as outlined in **6.2** except that test distance during calibration is not related to the luminaire test distance and assigned 90 degree candlepower should be converted to footcandles.

The test distance should be selected as outlined in **6.1.**

The assigned normal (90 degrees) candlepower (**6.2.f**) may be converted to footcandles by dividing by the test distance squared. All subsequent footcandle readings should be related to this calculated value.

7.2—Luminaire Illumination Measurements—The electrical conditions should remain the same as in the calibration procedure. The luminaire should be suspended in a suitable position with respect to the plane of illumination measurements. If this position is in other than normal operating position, compensation should be made for temperature errors (see **6.3.2**). The area of the surface lighted by the luminaire should be divided into a suitable number of equal squares. Dimensions and layout of these squares should be such that significant differences in illumination will be indicated within the entire area which the luminaire is intended to illuminate. Illumination measurements should be made at the center of each square.

7.3—Brightness measurements should be made in accordance with **6.4.**

7.4—Computation of Test Results—All illumination measurements should be corrected to the values that would result if the test lamp delivered rated lumens by applying the correction factor developed through the calibration of the photometer and the test lamp or lamps.

8. Test Reports—should describe all significant data found concerning the luminaire tested and the data should be listed in a manner that will allow derivation of the maximum amount of information.

It is recommended that the items listed below be included and that report forms of the general type shown in Appendix B be used.

8.1—Luminaire Description

a. Manufacturer's name, type and catalogue numbers

b. Type of mounting

c. Reflecting surfaces—shape, material, dimensions (including simulated ceiling if used)

d. Enclosing media, louvers, etc.—description of

e. Drawing showing shape, dimensions, light center positions, angles of cut-off and/or shielding with arrows indicating points at which brightness measurements were made.

f. Ballast data — single or two-lamp, power factor corrected or uncorrected, voltage range, midpoint voltage and frequency.

8.2—Test Lamp Description

a. Number, type, bulb designations and length

b. Rated watts

c. Rated lumen output

d. Color

e. Rated lamp brightness

8.3.—Photometric Data

8.3.1—*General Lighting Characteristics*

a. Candlepower distribution curves in designated places.

b. Tabulation of candlepower values for average candlepower distribution.

c. Tabulation of lumens corresponding to average candlepower distribution.

d. Tabulation of lumens and percentages of bare lamp output for zones 0°-40°, 0°-60°, 0°-90°, 90°-180° and 0° to 180°.

e. Tabulation of brightness readings (preferably footlamberts) at designated points.

f. Test distance.

8.3.2—*Localized Lighting Characteristics*

a. Footcandle distribution chart

(1) Perpendicular distance to lighted surface.

(2) Angular position of luminaire with respect to lighted surface.

b. Tabulating of brightness readings (preferably footlamberts) at designated points.

8.4—Date and Testing Agency

References

1. Baumgartner, G. R.: "Practical Photometry of Fluorescent Lamps," Illuminating Engineering, Vol. XXXVI, p. 1340 (December, 1941).

2. Little, W. F. and Salter, E. H.: "Measurement of Fluorescent Lamps and Luminaires," Illuminating Engineering, Vol. XLII, p. 227 (February, 1947).

3. Potter, Wentworth and Darley, W. G.: "The Design of Luminaires for Fluorescent Lamps," Illuminating Engineering, Vol. XXXV, p. 759 (November, 1940).

Winkler, F. C.: "Fundamental Facts of Fluorescent Fixture Design," Illuminating Engineering, Vol. XXXVII, p. 229 (April, 1942).

Maurette, R. G.: "Ten Years of Fluorescent Fixture Development," Illuminating Engineering, Vol. XLIII, p. 272 (March, 1948).

4. Linsday, E. A.: "Brightness of Cylindrical Fluorescent Sources," Illuminating Engineering, Vol. XXXIX, p. 23 (January, 1944).

5. "American Standard Practice for School Lighting," Illuminating Engineering, Vol. XLIII (September, 1948).

6. "American Recommended Practice of Industrial Lighting," Illuminating Engineering, Vol. XXXIV, p. 369 (April, 1939).

7. Harrison, Ward and Anderson, E. H.: "Coefficients of Utilization," *Transactions of I.E.S.* Vol. XV, p. 97 (March, 1920).

Weitz, C. E. and Amick, C. L.: "Luminaire Utilization as Affected by Candlepower Distribution," Illuminating Engineering, Vol. XLIII, p. 65 (January, 1948).

Appendix A

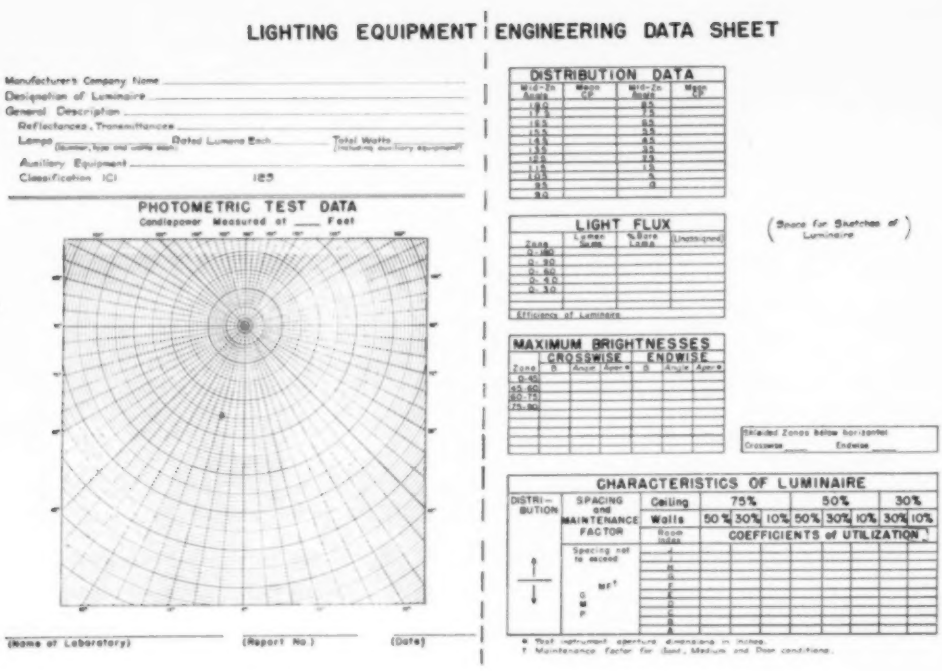
Constants for the Conversion of Candles into Lumens

Spacing 10° Vertical x 360° Horizontal

Vertical Angles	K
5°	0.095
15°	0.284
25°	0.463
35°	0.628
45°	0.774
55°	0.897
65°	0.993
75°	1.058
85°	1.091

See Appendix B

next page.


LIGHTING EQUIPMENT ENGINEERING DATA SHEET

Manufacturer's Company Name
Designation of Luminaire
General Description
Reflectances, Transmittances
Lamps (Number, type and watts each) Rated Lumens Each Total Watts (Including auxiliary equipment)
Auxiliary Equipment
Classification IC 185

PHOTOMETRIC TEST DATA
Candlepower Measured at ___ Feet

(Name of Laboratory) (Report No.) (Date)

DISTRIBUTION DATA

Mid-Zn Angle	Mean CP	Mid-Zn Angle	Mean CP
180		85	
175		75	
165		65	
155		55	
145		45	
135		35	
125		25	
115		15	
105		5	
95		0	
90			

LIGHT FLUX

Zone	Lumen Sums	% Bare Lamp	Unassigned
0-180			
0-90			
0-60			
0-40			
0-30			

Efficiency of Luminaire

(Space for Sketches of Luminaire)

MAXIMUM BRIGHTNESSES

Zone	CROSSWISE B	CROSSWISE Angle	CROSSWISE Aper.*	ENDWISE B	ENDWISE Angle	ENDWISE Aper.*
0-45						
45-60						
60-75						
75-90						

Shielded Zones below horizontal
Crosswise ____ Endwise ____

CHARACTERISTICS OF LUMINAIRE

DISTRIBUTION	SPACING and MAINTENANCE FACTOR	Ceiling	75%			50%			30%	
		Walls	50%	30%	10%	50%	30%	10%	30%	10%
		Room Index	COEFFICIENTS of UTILIZATION							
	Spacing not to exceed MH†	A								
		B								
		C								
		D								
		E								
		F								
		G								
		H								
		I								
		J								

* Test instrument aperture dimensions in inches.
† Maintenance factor for Dust, Medium and Poor conditions.

APPENDIX B

I.E.S. Guide for Photometric Testing of Street Lighting Luminaires — 1948

1. Objective—To provide a guide to promote uniform test results in the evaluation of the illumination characteristics of street lighting luminaires using filament and arc sources such as mercury and sodium.

2. Selection of Luminaires—Luminaires selected for test should be representative of the manufacturer's regular product.

3. Test Apparatus

3.1—TEST LAMPS—Test lamps should be selected for close conformance to manufacturer's design dimensions and construction, and seasoned in accordance with Appendix C. To insure stable lamp performance, filament lamps should preferably be operated at a constant current corresponding to approximately 75 per cent of rated lumen output. Mercury lamps should be operated at rated lamp watts, while sodium and other lamps should be maintained at rated current.

3.2—PHOTOMETRIC EQUIPMENT—The photometric equipment should be calibrated throughout the entire usable scale and the individual readings should be reproducible within a tolerance of ±2 per cent. Provisions should be made for correct optical positioning of luminaire in relation to the photometer axis and for candlepower measurement at any angular setting in both horizontal and vertical directions. Provision should be made for eliminating stray light from the test setup.

3.2.1—*Test Distance*—Test distance should be sufficient* to give representative candlepower measurement. The photometric test distance is, in general, defined as the distance from the light center of the lamp to the surface of the test plate or photosensitive element except with luminaires from which the light apparently emanates from a point other than the light center of the lamp. In this case an optical center at the point of apparent emission should be assumed for the test unless the angular deviation is too small to be significant.

3.3—ELECTRICAL INSTRUMENTS—The instruments used should have a good reproducibility of indication and give a large scale deflection for conditions under which they are used. Each meter should be free from frictional and/or heating errors. The accuracy of calibration depends upon the method of test used. (See "Methods," **4.1**).

4. Test Procedure

4.1—METHODS—Those generally employed in photometric testing are the Relative Method and the Direct Method. The Relative Method depends upon operating the test lamp in accordance with paragraph **3.1** without calibration of either lamp or photometer in terms of lumen output or of candlepower measured. After relative candlepower is measured and relative lumen output is calculated, the final candlepower is obtained by prorating the relative values to the manufacturer's rated lumen output for the type of lamp used. The Direct Method depends upon calibration of the test lamp in terms of lumen output and calibration of the photometer in terms

*A distance of 10 feet for street lighting luminaires has been generally used by several laboratories. Special cases may require greater distance.

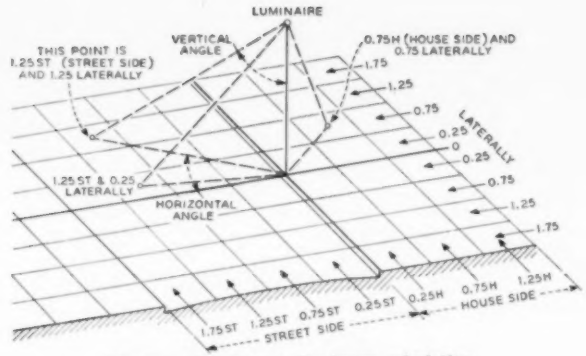


Figure 1. Street areas for lumen calculation.

of candlepower measured so that the readings from the luminaire tested will be directly in terms of candlepower. The following instructions should be followed to aid in consistent results.

4.1.1—*Relative Method*—The relative candlepower readings of the test lamp alone and of the lamp-luminaire combination should be made with the test lamp operating under identical electrical conditions in both tests.

4.1.1.1—The *test lamp's* average relative candlepower may be measured at each angular setting by rotating* the lamp below 85 rpm or by taking the average candlepower values in not less than 10 planes spaced equally around the lamp. The relative lumen output of the test lamp alone is obtained by the summation process using zonal lumen constants. (See Computation of Test Results, paragraph **6.1** and Appendix B.)

4.1.1.2—*The luminaire* — All candlepower readings should be corrected in proportion to the rated lumens of the test lamp by multiplying by the ratio of the rated lamp lumens to relative lamp lumens. For selection of angles for luminaire photometric measurements, see Section 5.

4.1.2—*Direct Method*—In the direct method both the test lamp and photometer should be calibrated against standards.**

4.1.2.1—The *test lamp* should be calibrated in an integrating sphere under the same electrical operating conditions as those used in testing the luminaire. Lamp current or wattage (depending upon type of source, see paragraph **3.1**) should be checked with a calibrated meter with a reproducibility of ±0.25 per cent. The selected current or wattage should be held constant throughout the test.

4.1.2.2 — The *photometer*, whether of photoelectric or visual type, should be calibrated against a candlepower standard.**

4.1.2.3—The *luminaire* candlepower distribution should be read with a calibrated test lamp and a calibrated photometer. Since the filament test lamp is operated at approximately 75 per cent of its rated lumens, both during calibration and during luminaire test, all photometric readings should be corrected to candlepower at rated lumens of the test lamp by multiplying the readings by the ratio of rated lamp lumens to calibrated lamp lumens.

4.2—Mounting of Luminaires — The luminaire should be mounted in the distribution photometer in such a manner that the proper optical axis of the luminaire coincides with the photometer axis and the light center of the lamp should be placed according to the manufacturer's instructions.

4.3—Cleaning of Optical Parts—All glass, reflectors and other optical parts should be thoroughly cleaned before candlepower measurements are made.

5. Selection of Angles for Photometric Measurements

5.1—General — The number of points measured photometrically in the various vertical planes and the angular spacing between points should be such as to permit plotting of well-determined candlepower distribution curves. Steps of 10-degree intervals in a vertical plane are usually satisfactory. Shorter intervals are recommended where the distribution curve is changing rapidly or is irregular in form. The number of planes explored should be determined by the nature of the distribution as to symmetry or irregularity and the end results desired from the test.

5.1.1—*Symmetric Type of Distribution*—For luminaires having a symmetric type of distribution the entire unit may be rotated below 85 rpm and readings taken in one vertical plane. The lamp may be rotated in the stationary luminaire provided several vertical planes are measured. For a stationary position, 10 vertical planes spaced equally about the luminaires are usually sufficient.

5.1.2—*Asymmetric Type of Distribution*—For luminaires having an asymmetric type of distribution, it is usually sufficient to measure the candlepower at 10-degree intervals, both vertically and laterally, except where the candlepower is changing rapidly. If desired, the lamp may be rotated in a stationary luminaire. Readings should be taken in vertical planes at 0 degrees, 90 degrees, 180 degrees, 270 degrees and in the plane of maximum candlepower. Candlepower in the cone through the point of maximum candlepower should be determined. Angular relations should be considered as follows:

Vertically —

0 degrees at *nadir*
90 degrees at *horizontal*
180 degrees at *zenith*

Laterally (measured clockwise) —

0 degrees at right angle to curb toward street side.
90 degrees parallel to curb in direction of traffic movement.
180 degrees at right angle to curb toward house side.
270 degrees parallel to curb toward oncoming traffic.

6. Computation of Test Results—The process of developing useful results involves the following steps:

6.1—Changing of the photometer readings into candlepower values at

*Rotation may influence the lamp characteristics to a degree of appreciable consequence in the Direct Method. See Photometry of Gas-Filled Lamp Bulletin of the Bureau of Standards, Vol. 12, 1915-16, p. 587.

**A lumen or candlepower standard is a light source which has been calibrated by a recognized standardizing laboratory as to lumen output and/or candlepower in a given direction.

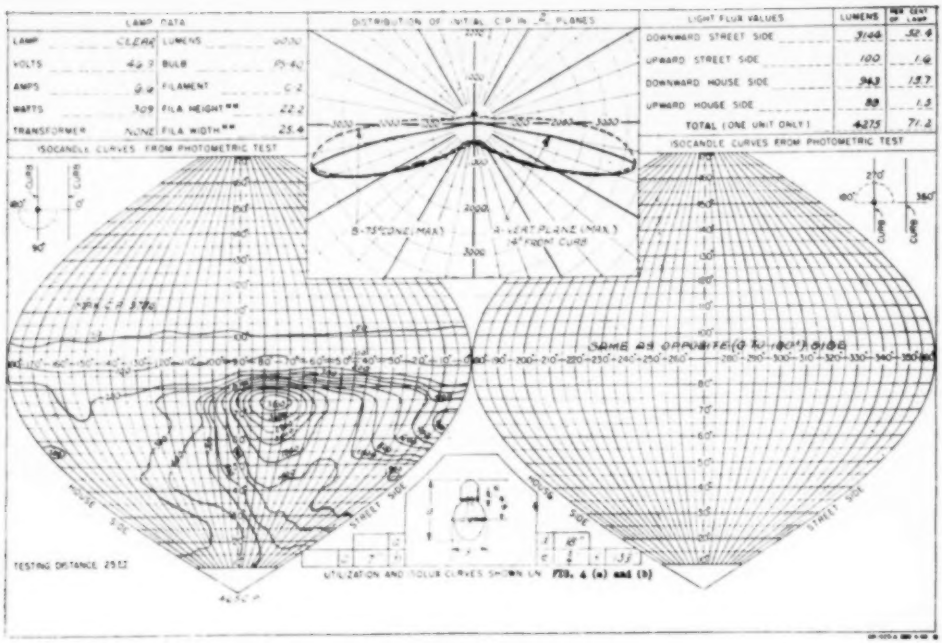


Figure 2.

rated lumen output of the lamp and determining the lumens within each area explored. The table in Appendix B gives the factors by which the average zonal candlepower is multiplied to give the lumens output for that zone or angular area.

6.2—Summing up the lumens in all the areas and dividing by the total bare lamp lumens, gives the total efficiency of the luminaire.* The total light output should be subdivided into four sectors of a sphere surrounding the luminaire expressed in terms of per cent of the total bare lamp lumen output:

(a) Downward light on street side
(b) Upward light on street side
(c) Downward light on house side
(d) Upward light on house side

6.3—Plotting the shape of the candlepower curve in the maximum cone, the maximum vertical plane and optionally an isocandle curve. For symmetrical type of distribution candlepower results should be represented by an average curve of the vertical planes. For asymmetric type of distribution, maximum (right and left) candlepower values as well as the average of right and left should be reported if an axis of symmetry is apparent.

6.4—Computing of utilization efficiencies, street side and house side, for ratios of width of street to mounting height up to 5.0. (See Appendix C).

6.5—Computing and plotting of isolux curves of horizontal footcandles for luminaires and mounting heights as shown in the Table of Appendix E for an area having a width equal to five times the mounting height toward the street side and not less than one times the mounting height toward the house side and a length equal to 10 times the mounting height in the direction of the 90-degree and 270-degree planes corresponding to up and down the street. A table of conversion factors for mounting heights ranging from 15 to 35 feet should be made available with footcandle values at 20, 25 or 30-foot mounting heights having a factor of 1.0. (See Appendix E).

7. Test Report—Test results should include:

A. Luminaire Description
- Manufacturer's name, type and catalogue number
- Reflector—shape, material, manufacturer's designation and dimensions
- Type and size of glassware or other enclosure and method of attachment
- Auxiliary reflecting devices
- Other essential information, including method of selection of sample.

B. Lamp Description
- Type, service and designation
- Rating—watts, lumens, volts or amperes
- Bulb, base and burning position
- Dimensions—light center length, filament construction and light source dimensions.

C. Photometer Data
- Position of filament in respect to luminaire orientation when lamp is not rotated.
- Distance from light center or apparent center at which photometer readings were made.

D. Distribution Curve, I.E.S. Type Distribution.

E. Isocandle curve plot (optional), average candlepower distribu-

*As an independent check, the luminaire efficiency may be measured in an integrating sphere.

tion in the maximum cone, and in the vertical planes of maximum candlepower.

F. Total lumen output of luminaires and per cent of lamp lumens; lumens and per cent of total lumens in four quadrants.

G. Utilization curves, street side and house side.

H. Isolux lines of horizontal footcandles for at least one representative lamp size.

Appendix A — Suggested Seasoning Schedules

1. General — All lamps, which are to be photometered, should be burned first as indicated in the seasoning schedules below.

2. Large Vacuum Electric Filament Lamps

Watts	Volts	Fila. Const.	Design Life	Seasoning Min.	% Volts
Any	Any	S	0-1399	45	115
		S	1400 and above	60	115
		C	0-500	30	115
		C	501-999	45	115
		C	1000-1999	60	115
		C	2000 and above	60	120

3. Large Gas Filled Electric Filament Lamps

Any	Any	C	0-15	15	100
"	"	C	16-99	30	100
"	"	C	100-200	45	100
"	"	C	300	45	105
" (Except 1000 W—30V)		C	500	45	110
"	Any	C	750	45	110
0-200	"	C	800	45	115
201-299	"	C	800	60	115
300-2000	"	C	800	90	115
0-74	"	C	1000	45	115
75-150	32	C	1000	90	115
75-200	100-250	C	1000	45	115
300-2500	Any	C	1000	90	115
Any	"	C	1350	60	115
"	"	C	1500	60	115
"	"	C	2000	60	120
900W Proj.	32	C	100	45	100% Amps.
Series (All types)		C	2000	240	108% Amps.
1000	30	C	500	{ 120	105 }
				{ 240	100 }
(Series Gr. Replacement) (All Types)		C		240	112% Amps.

4. New or Special Lamps—The seasoning schedule for a new lamp type shall be similar to a listed type which, in regard to design life, most closely agrees with the new type even though the two types have not the same service classification. In case of doubt, use that schedule which gives the longest period of seasoning — it is preferable to over season rather than under season a lamp.

5. Gaseous Discharge Lamps—Standard seasoning practice for mercury vapor lamps is to burn 200 hours at rated watts, and for sodium lamps 200 hours at rated current.

Appendix B

1. Constants for the Conversion of Candles into Lumens

Spacing 1° Vertical x 360° Horizontal

Vertical Angles	K	Vertical Angles	K	Vertical Angles	K	Vertical Angles	K
45° 30'	0.07822	68° 30'	0.1020	57° 30'	0.09249	80° 30'	0.1082
46° 30'	0.07954	69° 30'	0.1027	58° 30'	0.09350	81° 30'	0.1085
47° 30'	0.08085	70° 30'	0.1033	59° 30'	0.09449	82° 30'	0.1087
48° 30'	0.08213	71° 30'	0.1040	60° 30'	0.09544	83° 30'	0.1089
49° 30'	0.08339	72° 30'	0.1046	61° 30'	0.09637	84° 30'	0.1092
50° 30'	0.08462	73° 30'	0.1051	62° 30'	0.09727	85° 30'	0.1093
51° 30'	0.08582	74° 30'	0.1057	63° 30'	0.09814	86° 30'	0.1095
52° 30'	0.08700	75° 30'	0.1062	64° 30'	0.09898	87° 30'	0.1096
53° 30'	0.08815	76° 30'	0.1066	65° 30'	0.09979	88° 30'	0.1096
54° 30'	0.08928	77° 30'	0.1071	66° 30'	0.10057	89° 30'	0.1097
55° 30'	0.09037	78° 30'	0.1074	67° 30'	0.10132		
56° 30'	0.09144	79° 30'	0.1078				

2. Constants for the Conversion of Candles into Lumens

Spacing 2° Vertical x 360° Horizontal

Vertical Angles	K	Vertical Angles	K
1°	0.00383	47°	0.1604
3°	0.01148	49°	0.1655
5°	0.01912	51°	0.1704
7°	0.02679	53°	0.1752
9°	0.03451	55°	0.1797
11°	0.04185	57°	0.1839
13°	0.04934	59°	0.1880
15°	0.05676	61°	0.1918
17°	0.06412	63°	0.1954
19°	0.07140	65°	0.1988
21°	0.07860	67°	0.2019
23°	0.08569	69°	0.2048
25°	0.09269	71°	0.2074
27°	0.09957	73°	0.2097
29°	0.10633	75°	0.2118
31°	0.11298	77°	0.2137
33°	0.11945	79°	0.2153
35°	0.12580	81°	0.2166
37°	0.13199	83°	0.2177
39°	0.13802	85°	0.2185
41°	0.14388	87°	0.2190
43°	0.14957	89°	0.2193
45°	0.15508		

3. Constants for the Conversion of Candles into Lumens

Spacing 5° Vertical x 360° Horizontal

Vertical Angles	K
2° 30'	0.0239
7° 30'	0.0715
12° 30'	0.1186
17° 30'	0.1648
22° 30'	0.2098
27° 30'	0.2531
32° 30'	0.2945
37° 30'	0.3337
42° 30'	0.3703
47° 30'	0.4041
52° 30'	0.4349
57° 30'	0.4623
62° 30'	0.4862
67° 30'	0.5064
72° 30'	0.5228
77° 30'	0.5352
82° 30'	0.5435
87° 30'	0.5476

4. Constants for the Conversion of Candles into Lumens

Spacing 10° Vertical x 360° Horizontal

Vertical Angles	K
5°	0.095
15°	0.284
25°	0.463
35°	0.628
45°	0.774
55°	0.897
65°	0.993
75°	1.058
85°	1.091

5. Constants for the Conversion of Candles into Lumens

Spacing 1° Vertical x 1° Horizontal

Vertical Angle	K	Vertical Angle	K	Vertical Angle	K
89.5	0.000305	59.5	0.000262	29.5	0.000102
88.5	0.000305	58.5	0.000260	28.5	0.000097
87.5	0.000305	57.5	0.000257	27.5	0.000150
86.5	0.000304	56.5	0.000254	26.5	0.000146
85.5	0.000304	55.5	0.000252	25.5	0.000140
84.5	0.000303	54.5	0.000248	24.5	0.000136
83.5	0.000303	53.5	0.000245	23.5	0.000131
82.5	0.000302	52.5	0.000242	22.5	0.000126
81.5	0.000301	51.5	0.000238	21.5	0.000121
80.5	0.000301	50.5	0.000235	20.5	0.000117
79.5	0.000299	49.5	0.000232	19.5	0.000112
78.5	0.000298	48.5	0.000228	18.5	0.000107
77.5	0.000297	47.5	0.000225	17.5	0.000092
76.5	0.000296	46.5	0.000221	16.5	0.000087
75.5	0.000295	45.5	0.000217	15.5	0.000081
74.5	0.000294	44.5	0.000214	14.5	0.000076
73.5	0.000292	43.5	0.000210	13.5	0.000071
72.5	0.000291	42.5	0.000206	12.5	0.000066
71.5	0.000289	41.5	0.000202	11.5	0.000061
70.5	0.000287	40.5	0.000198	10.9	0.000055
69.5	0.000285	39.5	0.000194	9.5	0.000050
68.5	0.000283	38.5	0.000190	8.5	0.000045
67.5	0.000282	37.5	0.000186	7.5	0.000040
66.5	0.000280	36.5	0.000181	6.5	0.000034
65.5	0.000277	35.5	0.000177	5.5	0.000029
64.5	0.000275	34.5	0.000173	4.5	0.000024
63.5	0.000273	33.5	0.000168	3.5	0.000019
62.5	0.000270	32.5	0.000164	2.5	0.000013
61.5	0.000268	31.5	0.000159	1.5	0.000008
60.5	0.000265	30.5	0.000155	0.5	0.000003

Horizontal Settings of 0°, 0.5°, 1.5°, 2.5°, etc. for each.
Vertical Settings of 0°, 0.5°, 1.5°, 2.5°, etc.

6. Constants for the Conversion of Candles into Lumens

Spacing 2° Vertical x 2° Horizontal

Vertical Angles	K	Vertical Angles	K	Vertical Angles	K
89	0.00122	59	0.00104	29	0.00059
87	122	57	102	27	55
85	121	55	100	25	51
83	121	53	097	23	48
81	120	51	095	21	44
79	120	49	092	19	40
77	119	47	089	17	36
75	118	45	086	15	32
73	116	43	083	13	27
71	115	41	080	11	23
69	114	39	077	9	19
67	112	37	073	7	15
65	110	35	070	5	11
63	108	33	066	3	06
61	107	31	063	1	02

Vertical Settings of 0°, 1°, 3°, 5°, etc. for each.
Horizontal Settings of 0°, 1°, 3°, 5°, etc.

Spacing 5° Vertical x 5° Horizontal

Vertical Angles	K	Vertical Angles	K	Vertical Angles	K
87.5	0.00780	57.5	0.00642	27.5	0.00352
82.5	755	52.5	604	22.5	291
77.5	744	47.5	562	17.5	229
72.5	726	42.5	514	12.5	165
67.5	704	37.5	463	7.5	099
62.5	676	32.5	409	2.5	033

Vertical Settings of 0°, 2.5°, 7.5°, 12.5°, etc. for each.
Horizontal Settings of 0°, 2.5°, 7.5°, 12.5°, etc.

Spacing 10° Vertical x 10° Horizontal

Vertical Angles	K	Vertical Angles	K	Vertical Angles	K
85	0.0304	55	0.0249	25	0.0129
75	294	45	214	15	076
65	276	35	174	5	026

Vertical Settings of 0°, 5°, 15°, 25°, etc. for each.
Horizontal Settings of 0°, 5°, 15°, 25°, etc.

Appendix C

Development of Utilization Curves

1. General—The following covers a method for computing utilization efficiencies of street lighting luminaires. It embodies two principal procedures, both of which have appeared in the *Transactions of the I.E.S.*[1, 2]

2. Photometric Tests—Candlepower distribution should be available in the form of an isocandle curve, Fig. 2, or in a tabulation of candlepower values taken at the angular positions as shown in Table I.

3. Computation of Flux Values

(a) The street area, roadway and sidewalk are divided into rectangular areas, whose dimensions are expressed in terms of the mounting height of the luminaire above the street plane, see Fig. 1 and Table I, and luminaire so oriented that the 90-degree and the 270-degree vertical planes form the dividing line between street side and house side. The lumens in each rectangular area are computed by multiplying the candlepower incident on the street at the center of each area by the proper area constant (solid angle subtended at the light center by the various areas). The summation of all the lumens within the area selected in rows along the street (Table I) shows the total flux, which, if divided by the rated lumen output of the lamp gives the utilization per lengthwise strip. The addition of the utilization values for all the strips gives the total utilization as shown in Fig. 3.

(b) Should an isocandle type of distribution be available as shown in Fig. 2, the use of Fig. 3 as a transparency will be helpful. Each point in Fig. 3 shows the center of a square or a rectangular area as tabulated in Table I and only points up to 4.75 times mounting height across street and 9.5 times mounting height along street are indicated on this chart; points beyond require a similar plot. This transparency diagram is superimposed on the isocandle distribution and candlepower values as interpo-

[1] Benford, F.: "Isocandles," *Trans. of I.E.S.*, Vol. XXI, p. 129 (February, 1926).

[2] Gray, S. McK.: "New and Simple Method for Presentation of Photometric Data of Street Lighting Luminaires," *Trans. of I.E.S.*, Vol. XXIX, p. 463 (June, 1934).

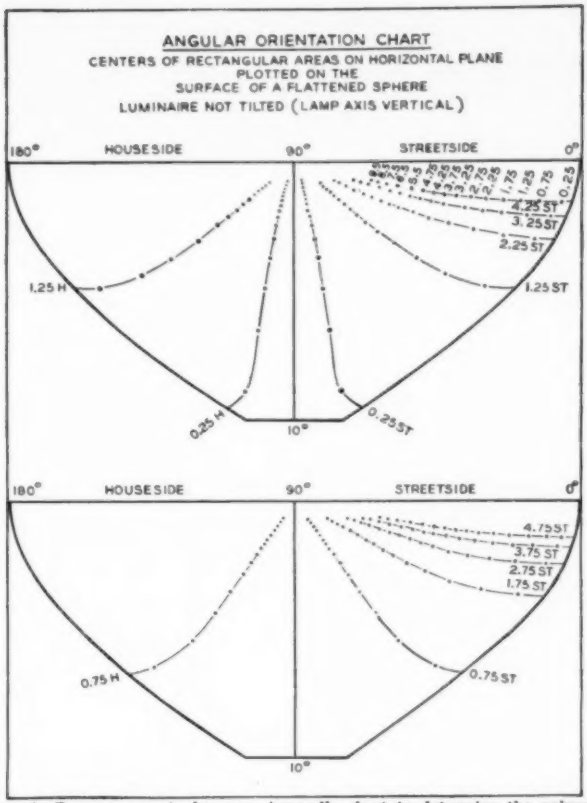


Figure 3. Transparency to lay over isocandle chart to determine the values of candlepower directed toward centers of rectangular areas. Two diagrams are used — one for each alternate lengthwise strip of rectangular areas.

lated are read off and tabulated as shown in Table II. The lumen factor times candlepower gives the lumens in each area. The top value indicates the factor, the middle value — the candlepower, and the bottom value equals the product of the two. A summation of these lumens lengthwise of street may then be tabulated as follows from which the utilization values are computed by dividing lumens by the rated bare lamp lumens.

Ratio	Zone Lumens	Lumens	% Utilization
0.5	2 × 491 = 982	982	16.4
1.0	× 478 = 956	1938	32.3
1.5	× 280 = 560	2498	41.6
2.0	× 124 = 248	2746	45.8
2.5	× 74 = 148	2894	48.2
3.0	× 44 = 88	2982	49.7
3.5	× 30 = 60	3042	50.8
4.0	× 18 = 36	3078	51.4
4.5	× 12 = 24	3102	51.7
5.0	× 9 = 18	3112	51.9

(c) The utilization curve is then plotted as shown in Fig. 4.*

*This method yields results which are within 3 per cent of the more accurate method described by Benford.[3]

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TABLE I—Angles and Lumen Factors for Calculation of Lumens

Distance* Across Street or Toward House	Symbols**	Distance Along Street* (Laterally)														
		0.25	0.75	1.25	1.75	2.25	2.75	3.25	3.75	4.25	4.75	5.50	6.50	7.50	8.50	9.50	∞
0.25	K	0.2012	0.1205	0.0595	0.0302	0.0167	0.0100	0.00635	0.00427	0.00300	0.00215	0.00288	0.00180	0.00117	0.00080	0.00058	0.0025
	B	45.0	71.6	28.7	81.0	83.7	84.8	85.6	86.2	86.6	87.0	87.4	87.8	88.1	88.3	88.5	
	X	19.3	38.3	51.9	60.5	66.2	70.1	73.0	75.1	76.8	78.1	82.4	83.3	84.0			
0.75	K	0.1203	0.0814	0.0459	0.0254	0.0148	0.00915	0.00595	0.00405	0.00291	0.00212	0.00282	0.00178	0.00114	0.00080	0.00057	0.0025
	B	18.4	45.0	59.0	66.9	71.6	74.8	77.0	78.7	80.0	81.0	82.2	83.4	84.3	85.0	85.5	
	X	38.3	60.7	55.6	62.3	67.1	70.7	73.3	75.3	77.0	78.2	79.8	81.3	82.4	83.3	84.0	
1.25	K	0.0595	0.0459	0.0302	0.0190	0.0120	0.00781	0.00530	0.00372	0.00268	0.00198	0.00270	0.00170	0.00112	0.00078	0.00056	0.0024
	B	11.3	31.0	45.0	54.5	61.0	65.6	69.0	71.6	73.6	75.2	77.2	79.1	80.6	81.6	82.5	
	X	51.9	53.6	60.5	65.1	68.8	71.7	74.0	75.9	77.3	78.5	80.0	81.4	82.5	83.4	84.0	
1.75	K	0.0302	0.0254	0.0190	0.0133	0.00919	0.00632	0.00448	0.00329	0.00238	0.00183	0.00254	0.00160	0.00108	0.00075	0.00055	0.0024
	B	8.1	23.2	35.5	45.0	52.2	57.5	61.7	65.0	67.6	69.8	72.4	75.0	76.9	78.4	79.6	
	X	60.5	62.3	65.1	68.0	70.7	72.9	74.8	76.4	77.7	78.8	80.2	81.6	82.6	83.4	84.1	
2.25	K	0.0167	0.0148	0.0120	0.00919	0.00675	0.00503	0.00373	0.00276	0.00209	0.00163	0.00230	0.00151	0.00102	0.00072	0.00053	0.0024
	B	6.3	18.4	29.0	37.8	45.0	50.7	55.3	59.0	62.1	64.6	67.8	70.9	73.3	75.2	76.7	
	X	66.2	67.1	68.8	70.7	72.6	74.3	75.8	77.1	78.2	79.2	80.4	81.7	82.7	83.5	84.2	
2.75	K	0.0100	0.00915	0.00781	0.00632	0.00503	0.00390	0.00296	0.00230	0.00180	0.00144	0.00211	0.00137	0.00096	0.00069	0.00051	0.0024
	B	5.2	15.2	24.4	32.5	39.3	45.0	49.8	53.7	57.1	59.9	63.6	67.1	69.9	72.1	73.8	
	X	70.1	70.7	71.7	72.9	74.3	75.6	76.8	77.9	78.8	79.7	80.8	81.9	82.9	83.6	84.2	
3.25	K	0.00835	0.00795	0.00530	0.00448	0.00373	0.00296	0.00244	0.00194	0.00155	0.00125	0.00190	0.00127	0.00089	0.00066	0.00049	0.0023
	B	4.4	13.0	21.0	28.3	34.7	40.2	45.0	49.1	52.6	55.6	59.4	63.4	66.6	69.1	71.1	
	X	73.0	73.3	74.0	74.8	75.8	76.6	77.7	78.6	79.4	80.1	81.1	82.2	83.0	83.7	84.3	
3.75	K	0.00427	0.00405	0.00372	0.00329	0.00276	0.00230	0.00194	0.00160	0.00134	0.00110	0.00170	0.00115	0.00084	0.00062	0.00047	0.0022
	B	3.8	11.3	18.4	25.0	31.0	36.3	40.9	45.0	48.6	51.7	55.7	60.0	63.4	66.2	68.5	
	X	75.1	75.3	75.8	76.4	77.1	77.9	78.6	79.3	80.0	80.6	81.6	82.6	83.2	83.8	84.4	
4.25	K	0.00300	0.00291	0.00268	0.00238	0.00209	0.00180	0.00155	0.00134	0.00112	0.00096	0.00150	0.00103	0.00076	0.00058	0.00044	0.0022
	B	3.4	10.0	16.4	22.4	27.9	32.9	37.4	41.4	45.0	48.2	52.3	56.8	60.5	63.4	65.9	
	X	76.8	77.0	77.3	77.7	78.2	78.8	79.4	80.0	80.6	81.1	81.8	82.7	83.4	84.0	84.5	
4.75	K	0.00215	0.00212	0.00198	0.00183	0.00163	0.00144	0.00125	0.00110	0.00096	0.00082	0.00136	0.00094	0.00070	0.00054	0.00041	0.0022
	B	3.0	9.0	14.8	20.2	25.4	30.1	34.5	38.3	41.8	45.0	49.2	53.9	57.7	60.8	63.4	
	X	78.1	78.2	78.5	78.8	79.2	79.7	80.1	80.6	81.1	81.5	82.3	82.9	83.6	84.1	84.6	

* Distances are expressed in terms of mounting height and are measured from point below light center.
** B = Azimuth or horizontal angle from direction crosswise to street.
X = Vertical angle from nadir.
K = Lumen factor.

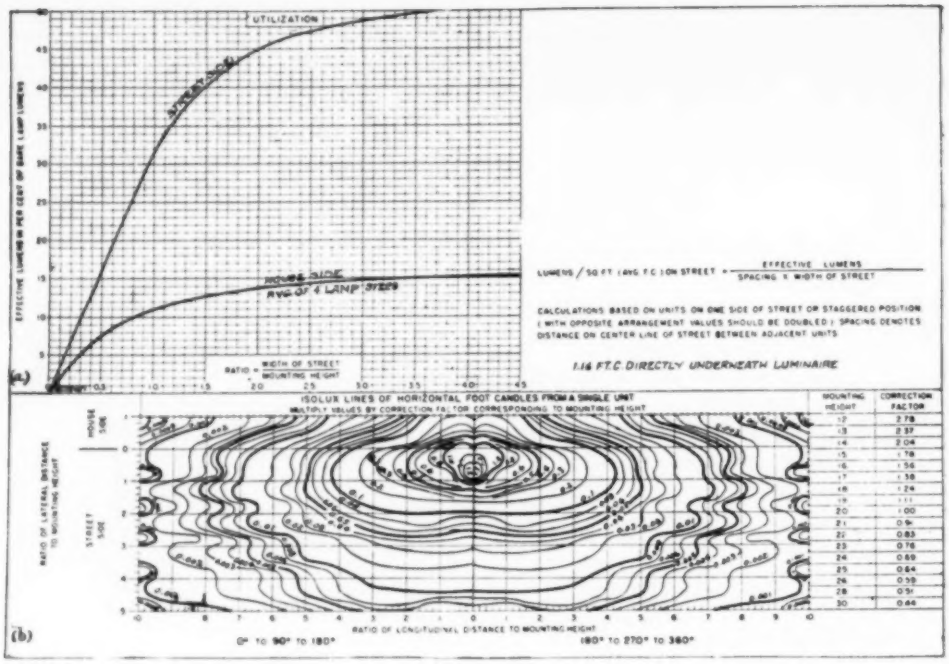
UTILIZATION
EFFECTIVE LUMENS PER 1000 OF BARE LAMP LUMENS
HOUSE SIDE
AVG OF 4 LAMP SPEEDS
RATIO = WIDTH OF STREET / MOUNTING HEIGHT
(a)
LUMENS / SQ FT (AVG F C) ON STREET = EFFECTIVE LUMENS / SPACING X WIDTH OF STREET
CALCULATIONS BASED ON UNITS ON ONE SIDE OF STREET OR STAGGERED POSITION (WITH OPPOSITE ARRANGEMENT VALUES SHOULD BE DOUBLED) SPACING DENOTES DISTANCE ON CENTER LINE OF STREET BETWEEN ADJACENT UNITS
1.16 FT.C. DIRECTLY UNDERNEATH LUMINAIRE
ISOLUX LINES OF HORIZONTAL FOOT CANDLES FROM A SINGLE UNIT
MULTIPLY VALUES BY CORRECTION FACTOR CORRESPONDING TO MOUNTING HEIGHT
RATIO OF LATERAL DISTANCE TO MOUNTING HEIGHT
HOUSE SIDE
STREET SIDE
RATIO OF LONGITUDINAL DISTANCE TO MOUNTING HEIGHT
0° TO 90° TO 180°
180° TO 270° TO 360°
(b)
MOUNTING HEIGHT
CORRECTION FACTOR
12 2.78
13 2.37
14 2.04
15 1.78
16 1.56
17 1.38
18 1.24
19 1.11
20 1.00
21 0.91
22 0.83
23 0.76
24 0.69
25 0.64
26 0.59
28 0.51
30 0.44

Figure 4.

TABLE II*—LUMEN VALUES FOR RECTANGULAR AREAS ON HORIZONTAL PLANE

Distance** Across Street or Toward House		Distance Along Street** (Laterally)															Total	Summation—Lumens
		0.25	0.75	1.25	1.75	2.25	2.75	3.25	3.75	4.25	4.75	5.50	6.50	7.50	8.50	9.50		
0.25	K C.P. Lumens	0.2012 590 119	0.1205 575 100	0.0595 1400 83.3	0.0302 1850 55.9	0.0167 2450 40.9	0.0100 3000 30.0	0.00635 3000 19.1	0.00427 3000 12.8	0.00300 2800 8.4	0.00215 2150 5.8	0.00208 2600 5.8	0.00180 1750 3.2	0.00117 800 0.94	0.00091 600 0.68	0.00058 500 0.29	090	690
0.75	K C.P. Lumens	0.1205 1200 145	0.0814 900 73.3	0.0459 1500 68.9	0.0254 2100 53.5	0.0148 2750 40.7	0.00915 1500 32.0	0.00595 1600 21.4	0.00405 1600 13.6	0.00291 1500 10.2	0.00212 1000 6.36	0.00282 2500 7.1	0.00178 1800 3.2	0.00114 1000 1.14	0.00093 800 0.64	0.00057 450 0.26	478	968
1.25	K C.P. Lumens	0.0595 1000 59.5	0.0459 950 43.6	0.0302 1300 39.2	0.0193 1450 27.6	0.0120 2000 24.0	0.00781 1000 23.4	0.00516 1500 18.6	0.00372 1600 13.8	0.00268 1500 9.4	0.00198 1000 6.5	0.00270 2800 7.6	0.00170 2000 3.4	0.00112 1500 1.68	0.00078 1000 0.78	0.00056 800 0.45	279	1247
1.50	K C.P. Lumens	0.0302 675 34.3	0.0254 650 36.5	0.0190 900 17.1	0.0135 1200 16.0	0.00919 1400 12.9	0.00632 1700 10.7	0.00448 2200 9.9	0.00329 2500 8.9	0.00238 2600 6.2	0.00183 2500 4.6	0.00254 2900 5.3	0.00160 1500 2.4	0.00108 1000 1.08	0.00075 900 0.68	0.00055 700 0.39	123	1320
2.25	K C.P. Lumens	0.0167 375 6.3	0.0148 525 7.8	0.0120 700 8.4	0.00919 950 8.7	0.00673 1200 8.1	0.00503 1400 7.0	0.00381 1550 5.9	0.00276 1700 4.7	0.00209 1850 3.9	0.00163 2000 3.3	0.00241 1750 4.0	0.00151 1500 2.3	0.00102 1250 1.28	0.00072 1000 0.72	0.00053 800 0.42	73	1483
2.75	K C.P. Lumens	0.0100 600 6.0	0.00915 500 4.6	0.00781 600 4.7	0.00632 750 4.7	0.00503 950 4.9	0.00390 1200 4.7	0.00296 1200 3.6	0.00230 1100 2.5	0.00180 1500 2.7	0.00144 1000 1.9	0.00211 1000 2.0	0.00137 800 1.1	0.00096 800 0.77	0.00069 700 0.48	0.00051 500 0.26	43	1486
3.25	K C.P. Lumens	0.0065 435 2.7	0.00595 475 2.8	0.00530 550 2.9	0.00448 650 2.9	0.00373 775 2.9	0.00296 950 2.8	0.00244 1000 2.44	0.00194 1000 1.94	0.00155 1000 1.6	0.00125 1000 1.3	0.00190 1000 1.9	0.00127 900 1.1	0.00089 800 0.71	0.00066 800 0.53	0.00049 700 0.34	289	1535
3.75	K C.P. Lumens	0.00427 600 1.7	0.00405 525 1.5	0.00372 450 1.7	0.00329 525 1.9	0.00276 650 1.8	0.00230 700 1.6	0.00194 725 1.5	0.00160 800 1.3	0.00134 800 1.1	0.00110 700 0.77	0.00170 600 1.0	0.00115 600 .69	0.00084 600 0.50	0.00062 550 0.34	0.00047 500 0.24	18	1581
4.25	K C.P. Lumens	0.00289 525 0.98	0.00291 325 0.95	0.00268 425 1.14	0.00238 525 1.2	0.00199 550 1.1	0.00166 600 1.1	0.00139 650 0.93	0.00114 650 0.82	0.00112 650 0.73	0.00088 600 0.58	0.00139 575 0.86	0.00093 500 0.52	0.00070 550 0.42	0.00054 500 0.29	0.00044 500 0.22	12	1585
4.75	K C.P. Lumens	0.00215 375 0.59	0.00212 275 0.58	0.00198 350 0.69	0.00183 500 0.92	0.00163 525 0.86	0.00144 500 0.72	0.00125 550 0.63	0.00110 600 0.63	0.00096 650 0.58	0.00082 500 0.41	0.00115 450 0.48	0.00093 500 0.47	0.00070 500 0.35	0.00054 450 0.24	0.00041 400 0.16	0	1593

* This is an example with specific values using Figures 2 and 3.
** Distances are expressed in terms of mounting height and are measured from point below light center.

Appendix D

Procedure for Computing Isolux Curves

1. The following procedure covers a method for computing isolux lines of horizontal footcandles from street lighting luminaires. The process is a sequel to the operation outlined in Appendix C, *i.e.*, it utilizes the lumen values tabulated in Table II to obtain the average footcandle values through dividing the lumens by the true area for the corresponding square or rectangle.

2. For distance-to-mounting-height ratios of 5 or less crosswise as well as lengthwise to street and at 20-foot mounting height, the divisor will be 0.5† x 20 feet x 0.5 x 20 feet or 100 square feet, and for ratios lengthwise from 5 up to 10 times the mounting height, it will be 0.5 x 20 feet x 1.0† x 20 feet or 200 square feet. Similarly for a 25-foot mounting height the areas become 156 and 312 square feet, respectively, and for a 30-foot mounting they are 225 and 450 square feet.

3. These footcandle values are then plotted at positions corresponding to the center of each square or rectangle and they form the basis from which points of equal intensities are plotted and isolux lines drawn in the manner as shown in Fig. 4. A set of conversion factors for other mounting heights should be supplied using the 20, 25 and 30-foot height as unity respectively as shown in Appendix E.

†Each rectangular interval in Table I is .5 the mounting height up to ratios of five times the mounting height. For ratios of 5 to 10, the interval is one times the mounting height.

Appendix E

Conversion Factors in Terms of 20-, 25- and 30-Foot Mounting Heights

Mounting Height	Conversion Factors I	II	III
15	1.78		
16	1.56		
17	1.39		
18	1.23	1.93	
19	1.11	1.73	
20	1.00	1.56	
21	0.907	1.42	
22	0.826	1.29	1.86
23	0.757	1.18	1.70
24	0.694	1.09	1.56
25	0.640	1.00	1.44
26		0.925	1.33
27		0.857	1.24
28		0.797	1.15
29		0.743	1.07
30		0.695	1.00
31			0.936
32			0.878
33			0.826
34			0.779
35			0.735

Refer to Table III, "Recommended Practice of Street and Highway Lighting, 1945," Illuminating Engineering, Vol. XLI, February, 1946, page 105, or "American Standard Practice for Street and Highway Lighting, D-12, 1948."

I.E.S. Guide for Photometric Testing of Fluorescent Lamps — 1948

1. Objective—To provide a guide to promote uniform test results in measuring the luminous flux and intensity of fluorescent lamps under controlled laboratory conditions. Two methods are:

1.1—The Integrating Sphere Method by which total luminous flux may be measured directly.

1.2—The Normal Candlepower Method in which luminous intensity is measured and luminous flux may be calculated.

2. Selection of Lamps—Lamps selected for test should be as nearly representative of the group as possible. Since tests are usually made on only a very small sample of the total product, the results obtained can serve only as an indication of average performance of the product and the degree to which the test samples represent the group affects the value of the test result.

The value of the test also depends on the method of sampling, size of sample, conditions of testing and many other factors. The effects of such variables are discussed in the "Manual for Presentation of Data" published by the American Society for Testing Materials.

3. Electrical Supply—The crest factor of the line voltage wave form should not deviate from 1.414 by more than two per cent. Deviation from sinusoidal wave form or the presence of excessive harmonics may have serious effect on lamp performance and should be avoided.

4. Test Conditions

4.1—Method of Starting — When preheat-start lamps are tested, it is recommended that they be started manually. Preheat time and current should conform to the limits set in Federal Specification W-L-131 (and current supplement) for Lamp Auxiliaries; Fluorescent. Pin connections should be the same as used in seasoning or life testing.[1]

4.2—Lamp Stabilization[1, 3] — Lamps should be operated for a sufficient time to assure stable operation, electrically and photometrically, before readings are taken.

4.3—Ambient Temperature — The room in which tests are performed should be maintained at a constant temperature of 80 degrees F. If the ambient temperature varies from 80 degrees F by more than one degree, it should be so stated in the test report. If corrections are applied for temperature variations, the correction factor should be stated in the test report. The room in which tests are performed should be free from drafts.

4.4—Electrical Values — Photometric values should be measured while lamps are operating in series with a linear reactor delivering rated current to the lamp or while operating in series with a standard reactor supplied with its rated line voltage. Watts, volts and current of each lamp should be measured and recorded in the Test Report. The "I.E.S. Guide for Electrical Measurement of Fluorescent Lamps, 1948" outlines provisions for measuring electrical values.

4.5—Stray Light — Adequate precautions should be taken to eliminate stray light from the test set-up.

5. Test Apparatus

5.1—Photometers

5.1.1—*Integrating Sphere Photometer** — Lamps should be mounted

*In general the length of straight lamp under test should not be greater than 85 per cent of the inside diameter of the sphere. The area of the light source should not exceed 2 per cent of the interior surface of the sphere. Departures from these restrictions will have little effect if a strict substitution method is employed.

preferably in a horizontal position with precautions taken to prevent supports or other adjacent objects from obstructing and absorbing light or affecting the lamp temperature. Precautions should be taken regarding proper diffusion of internal painted surfaces, placement of baffles and combined spectral response of cells, filters, sphere window and the sphere as an integrator.[2]

5.1.2—*Setup for Measuring Normal Candlepower*[3, 4]—The lamp should be mounted in open air, preferably in a horizontal position, with precautions taken to prevent supports or other adjacent objects from reflecting light or affecting the lamp temperature.

The distance between the test lamp and the photoelectric cell or test plate should be at least five times the lamp length. Shorter distances may be used if suitable corrections are made.

5.2—Color Correction[5] — When visual photometric methods are used and color differences exist between the standard lamps and the test lamps, the color differences should be minimized. When filters are used for color correction, proper allowance should be made for their absorption. When physical photometric methods are used and color differences exist between lumen standards and test lamps and the spectral response of photometric system deviates from the luminosity curve, corrections should be made.

5.3—Electrical Instruments—All instruments used should have good reproducibility of indication and large scale deflection for the conditions under which they are used. Each meter should be free from frictional and/or heating errors.

5.4—Photoelectric Cells—Photoelectric cells should be selected and calibrated to determine their spectral response, linearity, and fatigue characteristics within the range of values used in the test.

6. Test Procedures

6.1—Calibration*—The test setup should be calibrated at suitable intervals to assure accuracy of results.

6.2—Heating Effects—If fluorescent lamps are stabilized in the photometric sphere, care should be exercised to avoid raising the ambient temperature within the sphere above reported temperature due to heat generated by the lamp.

6.3—Electrical Measurements—Electrical characteristics of each lamp under test should be measured immediately before or after photometric measurements of each lamp are made.

6.4—Electrical Conditions—Photometric measurements should be made with the lamps operating as described in **4.4**. All instruments except the one indicating lamp current or line voltage (whichever is appropriate) should be out of the circuit. This restriction does not apply to series elements included as a part of the standard reactor impedance.

6.5—Normal Candlepower Measurements—Sufficient readings should be taken to allow proper evaluation of average normal candlepower around the lamp.

7. Computation of Test Results

7.1—Integrating Sphere — Light output of lamps under test may be established by the ratio of the readings between lumen standards and each test lamp.

7.2—Normal Candlepower — For fluorescent lamps, the normal or 90-degree candlepower may be established by averaging the readings as taken in **6.5**. The resultant 90-degree candlepower value of the lamp may be converted to lumens by multiplying by 9.25. (This factor is an average value for the various sizes of straight fluorescent lamps.[3])

*The substitution method, whereby the photometer or photometric setup is calibrated against lumen standards, is commonly used. In employing the substitution method, either fluorescent or electric filament lumen standards calibrated by a recognized laboratory may be used.

While fluorescent lumen standards are not as stable in their performance as filament standards, they allow use of a direct substitution method. Thus, both standard and test lamps may be similar in color, response to temperature changes, physical dimensions and light distribution. Since luminous flux and color characteristics of lamps change with hours of operation, it is recommended that lumen standards used regularly in test work be periodically checked against reference lumen standards.

The luminous flux of electric filament lumen standards remains substantially constant for repeated operation and variations in temperature. However, the difference between their spectral distribution and that of fluorescent lamps makes it necessary to exercise extraordinary care in the design, maintenance, and use of photometric equipments to avoid selective spectral absorption that would alter the finally observed radiation with resultant inaccuracies in measurements of luminous flux or luminous intensity.

Generally at least three lumen standards, usually of approximately the same light output as that of the lamp being tested, are used at each calibration.

8. Test Report—The test report should list all significant data concerning each lamp tested together with performance data. The report should also list all pertinent data concerning conditions of testing, type of equipment and type of lumen standards. Typical items that may be included are listed below in **8.1**.

8.1—Description of Test

- (a) Manufacturer's name and lamp designation.
- (b) Purpose of test.
- (c) Number of lamps tested.
- (d) Rated electrical values of lamp type.
- (e) Number of hours burned and operating cycle.
- (f) Ambient temperature and temperature correction factor, if any.
- (g) Lamp position during test.
- (h) Type of lumen standards used.
- (i) Photometric method and conversion factors, if any.
- (j) Sphere diameter or test distance.
- (k) Color correction method.
- (l) Lamps operated on constant lamp current or constant input voltage.
- (m) Conversion factor (normal candlepower to lumens).
- (n) Measured light output and electrical values (volts, watts, amperes) of each lamp and averages for group.
- (o) Date and testing agency.

References

1. "I.E.S. Guide for Electrical Measurement of Fluorescent Lamps, 1948" Illuminating Engineering Society.

2. Walsh, J. W. T.: "Photometry," Archibald Constable & Co., Ltd., London, 1926, and D. Van Nostrand Co., New York, N. Y. "National Bureau of Standards Handbook of Physical Measurements," Vol. V, Chapter 5, Washington, D. C., 1948.

3. Baumgartner, G. R.: "Practical Photometry of Fluorescent Lamps," Illuminating Engineering, Vol. XXXVI, p. 1340 (December, 1941).

4. Little, W. F. and Salter, E. H.: "Measurement of Fluorescent Lamps and Luminaires," Illuminating Engineering, Vol. XLII, p. 227 (February, 1947).

5. Crittenden, E. C. and Taylor, A. H.: "An Inter-laboratory Comparison of Colored Photometric Filters," *Transactions of I.E.S.*, Vol. XXIV, p. 153 (February, 1929).

Forsythe, W. E.: "The Present Status of Photometry." *Transactions of I.E.S.*, Vol. XXXI, p. 181 (February, 1936).

Little, W. F. and Estey, R. S.: "The Use of Color Filters in Visual Photometry." *Transactions of I.E.S.*, Vol. XXXII, p. 628 (June, 1937).

TELECAST

LIGHTING NEWS OF CURRENT INTEREST

Summary of Action Taken by Council at June Meeting in New York

The June meeting of Council, the last full Council of the current fiscal year, was held in New York June 8 at the Hotel Roosevelt. Present were: L. E. Tayler, President; C. H. Goddard, Walter Sturrock, Vice-Presidents; A. H. Manwaring, General Secretary; R. W. Staud, Junior Past-President; E. M. Strong, Treasurer; Myrtle Fahsbender, Carter Lewis, J. E. Mueller, Hoyt P. Steele, M. N. Waterman, Directors; Duncan M. Jones, Harry Grattan, Jr., W. A. Stannard, J. B. Browder, R. L. Biesele, Jr., Leo Hobbs (proxy for T. H. Shepherd), Regional Vice-Presidents; and Bruce Jensen, Finance Committee; George Taylor, Sustaining Membership Committee; James Ketch, Library Lighting Committee; S. B. Hibben, W. C. Randall; George Watters, Chairman-Elect Quebec Chapter; J. S. Schuchert; A. R. Hampsey, Chairman-Elect Pittsburgh Section; R. F. Hartenstein, Conference Committee; E. C. Huerkamp, Berlon Cooper and H. H. Magdsick, Publications Committee; G. F. Dean, new Canadian Regional Vice-President; Frank Reid, Toronto, Frank Mueller, Cleveland Section; J. Murraugh, Georgia Section, and F. D. Patterson, Toronto Section. From the I.E.S. staff, A. D. Hinckley, C. L. Crouch, G. R. Henninger, Ruby Redford, Clayton Ellis and Eve Fryer, also attended.

President Tayler opened the meeting with an introduction of guests present, of which there was a large delegation from Canada.

President's Report

At this final meeting of the 1948-1949 Council, President Tayler addressed the members, reporting on the state of the Society throughout its Sections and Chapters, as observed through his personal contact with them during the past year. Noting that he had attended all of the several Regional Conferences except one, in which exception he visited all of the Region's Sections, Mr. Tayler reported on the growing importance, as meetings of consequence, of the Regional Conferences. He noted that in taking on almost the stature of a national conference, these meetings offered valuable opportunity for discussion from the floor, though one being missed in some instances. The Northeastern Regional Conference in Hartford, initiated parallel sessions at its meeting in May, and the East Central Conference at Harrisburg held a Service Forum prior to its technical session. In addition to the I.E.S. Regional Conferences, Mr. Tayler was impressed with the excellent lighting conferences sponsored this past year by a number of the Sections and Chapters, themselves important local meetings most effectively conducted.

New Chapter S. E. Florida

Acting on recommendation voted by the Council Executive Committee at its meeting in Hartford, Conn., on May 11, Council unanimously approved the chartering of a new I.E.S. Chapter in Miami, Florida, to be known as the Southeast Florida Chapter, and including the Florida Counties of Dade, Bravard, Palm Beach and Munroe. Petition for this Chapter had been made to the Executive Committee in May, at which time it was indicated the group had satisfied all Constitutional requirements as to membership, meetings held, and formation of By-Laws. The new Southeast Florida Chapter was developed through the efforts of A. C. Bergh, Local Representative for Miami, who has been elected to serve as the Chapter's first Chairman. Earl J. Reeder, of the Miami Traffic and Transportation Department, will serve as Secretary.

Emblem for Fellows

Council also approved the recommendation of the Executive Committee that a suitable and distinctive lapel emblem design be made for use in connection with the Fellow grade. The design approved was the same as for Member and Associate, except that the emblem signifying membership in Fellow grade would have a white background.

Waiver of Dues for the Armed Services

A communication from the New Orleans Chapter, favorably recommended by the Executive Committee, was presented in connection with the Society's former policy in the waiving of dues for a member entering active military service. Acting on the Committee's recommendation, Council approved the practice followed by the Society during World War II again be established, whereby members entering the Armed Forces be placed on an inactive list without payment of dues and with privilege of resuming active membership upon request without loss of continuity in membership record. This action will be taken annually on such members, at the beginning of each fiscal year.

New Membership Figures

Recommendations of the General Board of Examiners, submitted by R. C. Kinney, Chairman, resulted in favorable action on the election and reinstatement of ten new members, and the transfer of five Associates to Member Grade. The Board reported also on the election of 66 Associate members and 15 Student members, and reported with regret the death of A. M. Atkinson, Member and E. B. Kirk, Associate member. A list of the newly-elected members is given elsewhere in the Telecast Section.

Favorable action on these elections, together with other changes in membership, brings the membership figures to those shown in the following tabulation.

September 30, 1948		June 8, 1949
6515	Total Membership	7242
21	Members Emeritus	25*
45	Fellows	43
1406	Members	1541
4908	Assoc. Members	5392
136	Student Members	241

*Includes 5 Fellows of the Society.

Sustaining Membership

George Taylor, Chairman reported to Council his committee's activities

during the past year, especially their special efforts to bring to the attention of the Society's sustaining membership the value of the Society's work to the art and to the industry. He reiterated the need for a brochure outlining I.E.S. aims and achievements. He recommended for election, and favorable action was taken by Council on two new Sustaining Members:

City of Tacoma, Light Division
Tacoma 2, Washington
Ray H. Weston, Official Representative.

Electron Corp.
4501 Galapago
Denver, Colorado
Floyd Vickers, Official Representative.

Quebec Chapter Established

Petition for the Society's first bilingual Chapter was made by Duncan M. Jones, Canadian Regional Vice-President, requesting a Charter for a Quebec Chapter, at Quebec City, Canada. Presented in both French and English, the petition, supported by approval of the Montreal Section, showed an active program already underway in Quebec, with a number of meetings conducted in the French language. Charter for the Quebec Chapter to include Quebec City and the vicinity within a radius of 50 miles was unanimously approved by Council. The new Chapter's first Chairman will be George A. Watters of the Quebec Power Co., whose efforts as Local Representative were largely responsible for the successful I.E.S. program in Quebec. Provisional secretary elected for the Quebec Chapter is H. R. Payson, Canadian General Electric Co.

Winnipeg Chapter

Duncan Jones further submitted a petition for a Chapter in Winnipeg, Manitoba, supported by a letter from the Toronto Section, relinquishing any members in this territory. Mr. Jones reported that all requirements for a Charter have been met by the group in Winnipeg, meetings held and pro-tem officers appointed, and further submitted that the Toronto Section felt their service to the Society could be more effectively expanded by the formation of a Chapter in the plains Provinces. Council unanimously approved formation of the Winnipeg Chapter, to include the Provinces of Alberta, Saskatchewan, Manitoba and that part of Ontario known as the Lake Head which includes the territory west of and including Fort William and Port Arthur. Charter officers elected for the Winnipeg Chapter are Edmund F. Wilson, Chairman, and T. W. Birt, Secretary.

In his discussion of the special territorial problems encountered in Canada, Mr. Jones outlined the Canadian Region's plan to eventually cover all of Canada's wide-spread area, with strategically located Sections and Chapters. He noted that Canada's population of some 14 million people was thinly spread over a territory larger than the United States, and it has been heretofore difficult to effectively carry out the Society's work throughout the entire country. The recent formation of a Chapter in the Maritimes, and now the establishment of Chapters in Quebec and Winnipeg, are forward steps in the Region's eventual plan to establish two Regions in Canada, Western and Eastern Regions, with two Regional Vice-Presidents.

All Territory Assigned to Section or Chapter

In his report on the Society's Local Activity program, Mr. Sturrock submitted to Council as a motion, his recommendation that all unassigned areas in the United States and Canada be assigned to a Section or Chapter. Council's favorable action on this motion changed the boundaries of a number of Sections and Chapters to include hitherto non-section territories, as follows:

New Orleans Chapter — All of Louisiana except western tier of counties at present assigned to the Southwestern Section, and all of the state of Mississippi.

Utah Chapter — In addition to all of the state of Utah, territory now includes the southern part of Idaho and all of the state of Nevada except five counties assigned to the Mother Lode Chapter.

Island Empire Chapter—Eastern part of Washington, northern part of Idaho and all of the state of Montana.

British Columbia Section—All of the Province of British Columbia.

Toronto Section—Province of Ontario except city of Ottawa and the surrounding towns of Arnprior, Brockville, Carleton Place, Cornwall, Hawkesburg, Ottawa Perth, Prescott, Renfrew, Smith Falls and Vankleek Hills which are assigned to the Ottawa Chapter; and the counties of Halton, Wellington, Waterloo, Oxford, Haldimand, Lincoln and Welland, which are assigned to the Hamilton Ontario Chapter.

Georgia Section — To the state of Georgia has been added the entire state of Alabama.

Capital Section—To the present area has been added the southeastern part of West Virginia.

Tennessee Valley Chapter — To the present area of the state of Tennessee has been added the state of Kentucky except the northern part which is assigned to the Ohio Valley Section.

Mother Lode Chapter — Will include the territory within a 50-mile radius of Sacramento, California and all of the counties of Uba, Sierra, Nevada, Placer, Eldorado, Amador and Alpine in California, and five counties in Nevada, including Reno and Carson City.

Election of Officers

As required by the Constitution, a report of the election ballot, submitted by the Board of Tellers, Miss Virginia Skinner, Chairman, was read by the Executive Secretary. Details of the election of Society officers and council, and Section officers, are given in a separate item in this issue of the Telecast Section.

The election ballot on a Constitutional amendment, it was reported, resulted in approval of the proposed amendment. This drops from the annual dues invoices the dollar discount for payment of dues prior to November 30.

Dissemination Clause

The I.E.S. policy on the interpretation of its dissemination of knowledge clause has been under study by the Committee on Procedures and Policies for some time, since it was felt that the objects of the Society as stated in the I.E.S. Constitution restricted the dissemination functions of the Society to knowledge of the theory and practice of illuminating engineering. Specifically it provided that this may be done by publishing committee findings on subjects relating to the science and art of illumination, but does not restrict the Society from using any other means of accomplishing its objectives. While the committee felt that the Society's dissemination activities are a matter of program to be decided from time to time by Council, for the present they recommended the following policy statement based upon that adopted by Council in February, 1947. After revisions by Council the dissemination clause approved was:

The Illuminating Engineering Society concerns itself with the scientific, technical and aesthetic aspects of illumination. The first consideration in the Society's work shall be beneficial to the public interest. Its primary responsibility in disseminating information in education and in other services

is to its members. Beyond this the Society should strive to make its findings available by suitable means, especially through other scientific, professional and technical organizations and the various electrical and other industry groups concerned with lighting.

Definitions of Recommended Practices

On recommendation of the Committee on Procedures and Policies, Council approved the following stated definitions and comparisons for I.E.S. Recommended Practices and Lighting Study Project Reports.

A *Recommended Practice* is a committee report on the broadly accepted method or methods of lighting a particular field of application. It describes the practice or techniques in general use and as such represents the cross-section of knowledge which although perhaps having the origin in field studies, is primarily a product of time proven experience. Since it covers a field of application it probably describes the methods of lighting a number of related processes and locations.

A *Lighting Study Project Report* is a committee report on the results of specific field studies conducted to establish satisfactory method or methods of lighting the processes, tasks or locations involved. It probably consists of a series of related unit studies all of which go to make up the lighting of a particular field application.

A Recommended Practice presupposes sufficient accumulated knowledge and particularly experience to be able to write a thorough treatment of the generally accepted methods of lighting.

A Lighting Study Project presupposes that inadequate knowledge is available as to how to solve a particular lighting problem or that previous treatments are only partially satisfactory.

A Recommended Practice may grow out of a Lighting Study Project after sufficient time has elapsed to allow accumulated experience to confirm the original field studies and to allow the study solutions to become broadly or generally accepted.

Two other reports submitted by the Committee on Procedures and Policies, also approved by Council established an I.E.S. procedure for the election and maintenance of Sustaining Members, and an I.E.S. procedure for obtaining American Standards Association approval for technical reports and standards.

Committee Reports Approved

Technical committee reports submitted to Council and approved for acceptance and publication included:

Task Comittee on Wartime Lighting Practices. This committee submitted a report in line with its assignment to "Solicit, assemble and compile a record of studies on dimouts, blackouts and defense lighting related to World War II.

Committee on Daylighting. The committee presented and Council approved a "Recommended Practice of Daylighting" based on a two-year study.

"Lighting of Steel Mills, Part I — Open Hearth," submitted by the Committee on Lighting Study Projects in Industry, was approved for publication.

"Guide for Outdoor Illumination Tests, Part I — Street Lighting Installations; and Part II — Floodlighting Installations," submitted by the Committee on Testing Procedure of Illumination Characteristics, was approved for publication.

"Uniform Methods of Presentation and Calculation of Room Indexes, Coefficients of Utilization and Maintenance Factors," a report submitted by the Committee on Lighting Design Practice, was approved for publication.

Local Activities Conference for Incoming Chairmen

A special conference for incoming Section and Chapter Chairmen of I.E.S. was held at the General Electric Auditorium, New York City on June 9, at which was discussed the many problems encountered by local Board of Managers in the operation of Sections and Chapters. This was the third such conference held during the past few years, the discussions having been found so valuable to newly-elected Chairmen that annual repeats were requested.

Some thirty Chairmen and Regional Vice-Presidents, representing twelve Sections and Chapters from many parts of the country attended the meeting. Some of the problems discussed included:

Relation of Sections and Chapters to the National Society — Reports — Voice in Council — Use of Council Minutes.

Section and Chapter Meetings. Educational Programs. Use of the Society's publications. Architectural competitions. Attendance. Selection of subjects and speakers. Technique of running a meeting. Special local projects.

Residence Lighting Forums. Programs for, and its relation to the Section. Study Clubs.

Section and Chapter facilities for operation. Handling of local budgets. Budget requirements for extension work. Local Representative's activities. Student Branches. Areas and boundary lines.

1949-1950 Regional Conference schedules and programs.

I.E.S. Membership—interpretation of requirements for election to several grades. Membership campaign. Literature to solicit new membership. Permanent Treasurers and Secretaries.

Selection of Section, Chapter and National officers. Medallists, Fellows and Members Emeritus.

Sustaining Membership Activities

Some very valuable information developed from this meeting. All of the attending local officers, as well as those unable to come to New York, will receive a complete report covering the discussions, which is expected to clarify many problems experienced by the Boards of Managers.

Members attending the conference were:

Capital Section—Harry Grattan, Jr., Regional Vice-President.

Eastern Pennsylvania Chapter — Wm. Robinson.

Georgia Section — J. B. Browder, Regional Vice-President; Jack Murrah.

New England Section—Willard Allphin; C. H. Goddard.

New York Section—R. R. Brady, Carroll O'Shea; Priscilla Presbrey; Caroline Horn; Myrtle Fahsbender, Director; S. G. Hibben, Vice President.

Michigan Section—W. A. Stannard, Regional Vice-President; L. E. Tayler, President.

Cleveland Section—Frank E. Mueller; Walter Sturrock.

Connecticut Section—R. Rogge; W. McCormick.

Toronto Section—F. Reed; G. F. Dean; F. D. Patterson.

Montreal Section — A. Mendel; D. M. Jones, Regional Vice-President.

Quebec Chapter—George Watters.

Pittsburgh Section—J. S. Schuchert, Regional Vice-President; A. R. Hampsey.

I.E.S. Staff—A. D. Hinckley, Executive Secretary; C. L. Crouch, Technical Director; Ruby Redford, Production Editor; C. E. Ellis, Advertising Manager.

Cold Cathode Lighting Forum Held in Havana

Leading Cuban architects, lighting engineers and commercial executives attended the first Cold Cathode Lighting Forum to be held outside the U. S., when they met May 11 at the Sevilla-Biltmore Hotel in Havana. The Forum covered technical, production and performance phases of cold cathode lighting, and included exhibits of equipment of leading manufacturers in this field.

The Cuban forum and exhibit is one of a series of such affairs staged during the past year in key cities of the United States.

Connecticut Section is Host to Northeastern Regional Meeting

The two-day conference of the Northeastern Region at the Bond Hotel in Hartford, Connecticut May 12-13, drew a paid registration of 130 persons plus a sufficient margin of visitors to put the attendance at the opening session at 127; 148 people attended the reception and banquet. One attractive and effective feature of the Hartford program was a two-hour period devoted to an informal "Hello There" hull and reunion session incidental to the registration to which the first morning was devoted. Of course, some of the early-comers got this activity started the night before.

Six technical and two general sessions were crowded into a busy program to provide a range of subject matter exceptionally broad for a regional meeting. Store, industrial, and residence lighting competed for attention and attendance in three parallel sessions Thursday afternoon. A spot check showed a concurrent attendance of 68, 47 and 27 respectively. Friday morning, a session devoted to the discussion of fluorescent sources, equipment, and material ran in parallel with a symposium on street and highway lighting. A spot check showed concurrent attendance about mid-session to be respectively 71 and 30. The Friday afternoon symposium on school lighting ran without competition and drew an attendance of about 95. Exceptionally attractive, comfortable and convenient facilities for all sessions were provided in the Centinel Hill Hall and associated rooms in the store of G. Fox & Co. which turned these facilities over to I.E.S. for the occasion.

PROGRAM

The opening session was comprised of the following features:

"Introductory Address" by Walter Sturrock, Vice-President, I.E.S.

"Address of Welcome" by R. D. Cutler, Vice-President, Hartford Electric Light Company.

"Conference Highlights" by V. J. Ouellette, General Chairman Northeastern Regional Conference.

The general session was presided over by Chairman Myrtle Fahsbender of the New York Section, and a Director of I.E.S. "Horizons In Lighting" was discussed at this session by Richard G. Slauer, of Sylvania Electric Products, Inc., Salem, Mass.

At Parallel Session "A" on Thursday afternoon, C. W. McCormick, Holophane Co., of the New York Section substituted for Kenneth E. Estler of the Connecticut Section as Chairman. This session featured a "Symposium on Store Lighting" comprised of the following:

1. "Modern Store Lighting from Management's Viewpoint" by Geore J. Kyte, G. Fox & Company, Hartford, Conn.

2. "Planned Interior Sales Lighting"; (a) F. W. Rode, consulting engineer with Edward E. Ashley, New York City; (b) Wentworth M. Potter, General Electric Company, Nela Park, Cleveland, Ohio.

At parallel Session "B," James M. Shute of the New England Section was Chairman. This session featured "Industrial Lighting Applications" as follows:

1. "Planned Industrial Lighting" by James C. Forbes, General Electric Co., Lamp Division, New York City.

2. "High Bay Lighting" by K. E. Estler substituting for Davis H. Tuck, Hollophane Co., Inc., New York City.

3. "Color in Industry" by L. E. Whitmoyer, E. I. du Pont de Nemours & Co., Inc., Philadelphia, Pa.

Parallel Session "C" featured a "Residence Lighting Symposium." Caroline E. Horn of the New York Section was Chairman. The three items on the program were:

1. "Trends in Home Lighting" by Jan Reynolds, Sylvania Electric Products, Inc., New York City.

2. "Color in the Home" by Bertha Schaefer, Bertha Schaefer Galleries, New York City.

3. "Custom Lighting in the Home" by Thomas S. Kelly, Thomas Smith Kelly Lighting, New York City.

At the general session on Friday morning, G. W. Beals, Regional Vice-President I.E.S., was Chairman. "What I.E.S. is Doing for You" was discussed by C. L. Crouch, Technical Director, I.E.S., New York City. "I.E.S. Activities" were described and explained by Lee Tayler, President of I.E.S.

At Parallel Session "A" on Friday morning Henry J. Wilson of the New England Section was Chairman. "Technical Discussions of Fluorescent Sources, Operating Equipment and Materials for Lighting" was presented as follows:

1. "Gaseous Tube Sources" by Walter Sturrock, General Electric Company, Nela Park, Cleveland, Ohio.

2. "Ballasts and Operating Equipment" by Ernest H. Salter, Electrical Testing Laboratories, Inc., New York City.

3. "Plastics for Lighting" by C. N. Sprankle, Sandee Mfg. Co., Chicago, Ill.

At Parallel Session "B" Robert S.

COMMITTEE members responsible for the recent successful Regional Conference held by the Northeastern Region of I.E.S. at Hartford, Conn. Front row, from left: V. J. Ouellette, Caroline E. Horn, K. E. Estler, G. W. Beals (Regional Vice-President) and R. O. Mills. Back row, from left: H. J. Wilson, S. F. MacLean, P. S. Rogge, J. F. Dougherty, R. G. Slauer and C. W. McCormick.

Newhall, of the Connecticut Section was Chairman. A "Symposium on Street and Highway Lighting" was presented as follows:

1. "Planned Street Lighting" by Gene Ray, Hollophane Co., New York City substituting for Bruce J. Jensen, Public Service Electric & Gas Co. of Newark, N. J.

2. "New Developments in Street Lighting Equipment" by Frederick M. Spaugh, General Electric Co., Lynn, Mass.

3. "Future of Street Lighting" by Philip N. Clerke, Street Lighting Engineer, Westinghouse Corporation, Boston, Mass. substituting for Edgar B. Karns, of Cleveland, Ohio.

At the general session Friday afternoon a "Symposium on School Lighting" was presented. Roger T. Waite of the Connecticut Section was Chairman. The three items on the program were:

1. "An Engineer Looks at Modern School Lighting" by J. L. Kilpatrick, Silvray Lighting, Inc., New York City.

2. "An Educator's Viewpoint on Modern School Lighting" by Dr. Rexford Souder, Asst. Superintendent of Schools, Brookline, Mass.

3. "Ways and Means of Achieving Better School Lighting" by R. D. Bradley, DayBrite Lighting, Inc., New York City.

Highlight of the entertainment program was the presidential reception, banquet and dance given in the ballroom of the Bond Hotel Thursday evening, and presided over by Preston S. Millar of the New York Section as Toastmaster. Guests of Honor were President and Mrs. Lee E. Tayler. Guest Speaker was Austin D. Barney, President of the Hartford Electric Light Company. Entertainment was provided by a very popular local male quartet comprised of 4 Hartford boys known as "The Linen Dusters."

Special entertainment features for the women guests included a 4-hour sight-seeing bus trip and luncheon Friday. To accommodate maximum flexibility in individual taste, the committee did not provide organized luncheons for either day of the session.

Committees

It takes a program to make a meeting, and people to work out a program. The people officially responsible for the success of the Hartford Meeting are listed below; all are members of the Connecticut section, except as noted:

General Conference Committee: Victor J. Ouellette, chairman; Paul V. Hayden, vice chairman; Regional Vice-President G. W. Beales, K. E. Estler, W. D. Gorman, S. F. MacLean, H. J. Wilson of the New England Section, Caroline E. Horn of the New York Section.

Papers Committee: R. G. Slauer of the New England Section, chairman.

Program Committee: C. W. McCormick, chairman.

Finance Committee: E. R. Cole, chairman.

Hotel Committee: J. F. Dougherty, chairman.

Publicity Committee: R. S. Rogge, chairman.

Entertainment Committee: W. N. Warnes, chairman.

Registration-Reception Committee: R. O. Mills, chairman. Local I.E.S. representative.

Horizons in Lighting

In speaking to the topic "Horizons in Lighting" Mr. Slauer defended the relatively wide variety of fluorescent lamps now being manufactured, pointing out that as a general rule lamps are designed and manufactured in line with consumer demand. He stated that "the goals of lamp manufacturers coincide directly with those of fixture manufacturers, distributors, and consumers. A study of existing lamps shows that each one is an attempt to solve a particular problem of color, shape, circuit simplicity, and other desirable features." Mr. Slauer discussed footcandle levels from three different approaches — footcandle levels, footcandle standards, and footcandle engineering. With reference to levels, he considered 100 footcandles as a possible future standard, pointing out that some such installations exist now. He stated that "we are drifting toward such levels, but we should get there by research and not by continued drifting," suggesting economies, eye comfort, visual acuity, and personnel fatigue as being representative of the aspects to be considered. In considering footcandle standards, Mr. Slauer asked: "Why should we continue to crawl ahead at 5 or 10 footcandles per year; why not look ahead objectively and set up desirable standards in terms of considered and expected need?" He commented upon "footcandles" versus "brightness" in expressing a basic design objective, as one of many points meriting further study.

Store Lighting

"The majority of customers who come into department stores see only the sales areas and, although these areas are very important, they comprise less than half the area required to serve the public. ... These non-selling areas must be well lighted also if the people working there are to carry on their work efficiently, accurately, and with a minimum of eye strain." These were the comments of Mr. Kyte in discussing "Modern Store Lighting From the Management's Viewpoint." Mr. Kyte re-stated the fundamentals of good sales-area lighting ... "When we enter any area we must be able to see individual objects in the area ... with emphasis on special features that should be called to our attention. ... We must be able to remain within the area without feeling uncomfortable because of excessive concentration, or depressed by lack of concentration." Mr. Kyte briefly discussed the co-ordinated application in his own store of flush-mounted fixtures, cove lighting, troffer lighting, glass and plastic lenses of various types, and louvers of various types. He demonstrated a complete cycle of the special lighting provided in the theatre-like store auditorium where the session was being held.

Mr. Rode, Consulting Engineer of New York City in discussing "Planned Interior Sales Lighting," reminded his audience that for the complete refurbishing of a selling area in an old store, "the cost of the lighting fixtures required for the job is apt to be less than half the total cost of the job." He listed the following factors as underlying this conclusion: cost of fixtures; cost of re-wiring and hanging fixtures; cost of physical alterations necessary to accommodate new fixtures, such as moving air ducts and other piping, cutting and patching ceilings, etc.; and the redecoration required to create an environment properly suited to obtain maximum benefit from the new lighting installation. He mentioned also the increment in air-conditioning load represented by the actual increase in kwhr per unit of area.

In discussing the development of unit cost figures for estimating purposes, Mr. Rode discounted the cubic-foot unit, but gave the following per-square-foot estimate based upon "statistics kept on 75 postwar projects showing the cost that apparently can be supported economically by store management:

1. Fixtures and Equipment	60 to 90c sq. ft.
2. Rewiring and hanging	50c per sq. ft.
3. Sprinkler alteration	10c per sq. ft.
4. Duct alteration on relocation	12c per sq. ft.
5. Ceiling cutting and patching	15c per sq. ft.

Average total ranges from $1.47 to $1.77 per sq. ft. of selling area improved.

The foregoing figures are based upon a combination of fluorescent and incandescent lighting to provide 35 to 40 footcandles on the selling counters ... for every 10 footcandles of additional intensity, an increase of 15 per cent in cost may be expected, as the increase in costs of fixtures and rewiring are virtually proportional to the increase in intensity." Mr. Rode emphasized the necessity for flexibility in store lighting, characterizing a large department store as being "after all a stage on which the setting is continually being changed for the effective presentation of different merchandise," and credited G. Fox & Company with making ... "the first real effort to bring about the development ... some

ten years ago . . . of a fixture that permits varying the lighting intensity from 10 footcandles to 30 footcandles without fixture or circuit modification, and from any fixture concealed, adjustable high-intensity spotlights. . . ."

Mr. Potter discussed "Planned Interior Sales Lighting" also stating emphatically that, "there is greater need for the careful and thorough planning of store lighting today than at any previous time, because of the trend in illumination levels." Mr. Potter reviewed the different types of light sources and the general structural features of different types of fixtures available for store lighting. He also reviewed the several factors essential in the planning of store lighting, especially with reference to small stores, stressing the importance of the careful planning of localized "appraisal lighting" to suit the specific merchandise on display.

Mr. Potter pointed out that the current trend toward open or glass fronts from small stores makes particularly important the planning of both perimeter lighting and display lighting so as to compose into an attractive whole the picture that will be seen by the passer-by. Special lighting for the rear wall is especially important in adding depth. He reviewed some of the factors concerning the value of louverall or large louvered elements as "part of the pattern of flexibility in lighting service for stores." Mr. Potter set forth "Three A's" for guiding the design of store lighting:

1. Light for customer *attraction* to the store and to the features in the store.

2. Light for *appraisal* purposes to help the customer make a satisfying buying decision with speed and accuracy.

3. Light for *atmosphere*, including the entire environment.

Industrial Lighting

"Industry in general needs about four times the present average installed lighting intensity to bring it up to date in the light of present knowledge and experience," according to Mr. Forbes who spoke about "Planned Industrial Lighting." Carrying this thought further, he said, "if we could afford 10 footcandles 15 years ago, we can well afford 40 footcandles now, and its cost will represent no greater percentage of overall operating cost." Mr. Forbes stated that there were two basic premises underlying the approach to an industrial lighting job: To improve the appearance of shop areas as well as office areas; to improve the production efficiency of personnel.

In discussing the self-imposed question as to how an industrial relighting job can be handled most quickly and effectively, Mr. Forbes outlined six recommended lighting systems for industry:

1. *30-footcandle with filament.* For a high-bay area such as a foundry, 30-footcandles can be provided at minimum cost with filament lamps in conventional industrial reflectors, or with clusters of reflector lamps.

2. *30-footcandles with fluorescent.* In low-bay areas, such as a machine shop, a 30-footcandle level is satisfactorily obtained with 85-watt fluorescent lamps or their equivalent in 40-watt fluorescent or slimlines.

3. *30-footcandles with 40-watt fluorescent.* For an area such as a fine-assembly plant where the fixture mounting height is less than 14 feet, one recommended method of obtaining 30 footcandles is through the use of continuous rows of two-lamp 40-watt fluorescent industrial fixtures spaced from 8 to 12 feet apart.

4. *50-footcandles with 85-watt fluorescent.* For an area such as a machine shop handling large metal parts, where the fixture mounting height is greater than 14 feet, the use of two-lamp 85-watt fluorescent industrial fixtures mounted in continuous rows from 10 to 15 feet apart is recommended for a 50-footcandle level.

5. *30-footcandles with mercury and filament combined.* For a high-ceiling area such as an assembly shop for large machinery, with a fixture mounting height 30 feet or more, an installation of concentrating reflectors alternately housing mercury and filament lamps is recommended to provide lighting in the 50-footcandle range.

6. *80-footcandles with fluorescent units, grid pattern.* To provide 80-footcandles for faster and easier seeing on difficult, prolonged, and precision tasks, a grid system using continuous rows of two-lamp 40-watt fluorescent fixtures in two directions is recommended.

In the foregoing, the 30-footcandle classification is understood to embrace the range from 20 to 40-footcandles; the 50-footcandle classification to embrace the range from 40 to 60-footcandles; and the 80-footcandle classification to bracket the range from 60 to 100-footcandles.

High-Bay Lighting

In discussing "high-bay lighting," Mr. Estler spoke in place of Mr. Davis H. Tuck who was unable to be present. Emphasizing the fact that there is a distinct difference in the technique and equipment which should be employed for high-bay lighting as compared with low-bay lighting, he stated that "incandescent and mercury, or a combination of these, are ideal light sources for high-bay lighting because reflector equipment can be designed to give the required concentrating distribution . . . the AH-9 3000-watt mercury has no application in high-bay lighting, for two AH-12 1000-watt mercury lamps will produce more footcandle at the working level in a high-bay job than one 3000-watt AH-9 mercury lamp."

In discussing the relative merits of open versus closed units, Mr. Estler preferred open units as being more efficient overall. With reference to the matter of design calculation of lighting intensity, as compared with the average of effective light delivered at working levels under "in service" conditions, Mr. Estler stated that "the factor of effective light delivered to the working level from high-bay sources is something like 0.13 and definitely not the factor 0.70 which has been so commonly used." He listed 14 possible conditions which could intervene to reduce the actual level of illumination far below the calculated level, laying particular stress upon the "interception factor" where large machines, piles of material, personnel, or the work itself may completely screen a large share of the theoretically available light from the actual point of work.

Mr. Estler criticized the all-too-common vagueness of "in service" specifications for the level of illumination to be provided on an installation, suggesting the general adoption of a specific requirement for "in service" values to be determined six months after initial installation "to prevent close and careless price bidders from interpreting the term to mean performance when initially placed in service and turned over to the customer."

Color in Industry

In discussing "Color in Industry," Mr. Whitmoyer emphasized the need for a co-ordinated educational effort in selling to industry and commerce the practical and economic value of proper color application along with proper light application. He pointed out that "one of the principal hurdles encountered lies in human nature itself because, on the basis of personal opinion, each person is a color expert, and seldom do two amateur opinions of the same thing agree." He emphasized the fact that while the design and installation of an effective lighting drop necessarily "involves a lot of engineering, it is definitely not an exact science because it involves provision for seeing and this in turn involves people, and people have many different and conflicting concepts. Mr. Whitmoyer went on to remind his audience that "although the physicist approaches color in the terms of primary red, green and blue, the colorist considers a different red, a different green and yellow; while the psychologist thinks about red, green, blue, yellow, black and white," and that from a practical point of view, careful and competent planning is necessary. He discussed and illustrated color schemes ranging from restau-

rants to machine shops and textile mills.

Residence Lighting

"Proper lighting at the entrance door puts a smile on the house and helps to make it a home," Miss Reynolds told her audience in discussing "Trends in Home Lighting." She spoke emphatically of the need for coordination of lighting and decoration in the home, suggesting the appropriate use of both incandescent and fluorescent sources and fixtures, the fluorescent particularly for linear effects.

"Television is here to stay, and hence the proper lighting for its full enjoyment is important ... desirable to keep a secondary light in the room to reduce contrast ... preferably at the opposite end of the room and directly behind the viewers ... important that there be no light source in the direct line of vision ... no bright light directly on the screen, and no reflected light from the screen," said Miss Reynolds, "don't just buy a good television set and install it; surroundings are important ... but keep them simple."

Color.—"Very few people think they know anything about color; still fewer do know about color; but we can be sure the more they work with color the more surprises they will get—not all of them pleasant," according to Miss Schaefer. In discussing "Color in the Home," she emphasized architecture, lighting, and decoration as being especially closely inter-related in the home; further, that "... the selection of lamps and lighting are more critically important in the home where the emphasis is on esthetics rather than functionalism as in commercial and industrial installations. Consideration must be given not only to the intensity and the method of application of light, but to color as well, to achieve full appreciation of such important elements as fabrics, skin tones, and wallpaper composition. ..."

Miss Schaefer said further that "a color scheme, to hold up, must be considered in terms of its lighting. A good lighting plan not only will show the colors in their sense but will preserve rather than destroy the values of the colors. The type of lighting that flattens out a room plan, flooding it evenly with light and destroying shadows and high lights, destroys at the same time the color effect."

Whereas others spoke of end results, Mr. Kelly, in talking about "Custom Lighting in the Home," described the techniques used to obtain the results. With some paintings and sculptures and the aid of five spotlights, he demonstrated that the direction of lighting is just as important as the intensity for such objects, and showed that light from more than a single source is required to bring out the third dimension of a piece of sculpture. He showed samples of recessed units and lens combinations for ceiling installation in the home.

Sources

Of the various gaseous tube sources, Mr. Sturrock chose to discuss fluorescent and mercury vapor lamps "... because the past year has brought unusual developments in both fields." As representative samples of the developments, he cited the H-1 400-watt lamp and the H-5 250-watt lamp, used for general industrial lighting and also for "black light" effects. In general, the new mercury lamps were reported to have larger diameters and new designs of inner arc tubes, can be operated at lower temperatures and in any position, have a longer life and a greater lumen output, as well as a greater survival rate.

As for fluorescent lamps, Mr. Sturrock mentioned four categories: small or miniature sizes; intermediate sizes; long lamps, up to 6 or 8 feet in length; special shapes, such as "circline" etc. He mentioned size, shape, color and intensity as being the points of major interest. In comparing Krypton gas with the Argon gas currently widely used, Mr. Sturrock stated that the use of Argon is being continued in established standard styles of fluorescent lamps to avoid changes in ballast etc. which would tend to introduce complications in application. He pointed out, however, that Krypton is being used in the newer lamps, such as the 25- and 85-watt sizes, with improved operating results.

Auxiliary Equipment

In speaking about "Ballasts and Operating Equipment," Mr. Salter explained the theory of fluorescent lamp operation and discussed the necessity for starters. He also showed by means of slides how ballast design effects the lumen output per watt. He discussed the rise in temperature of various ballast parts caused, for example, by the operation of only one lamp of a two-lamp fixture.

Mr. Salter emphasized the necessity of considering the problem of heat dissipation in the planning of lighting installations, explaining that heat can be dissipated effectively by three methods: (1) convection, by venting for air currents; (2) conduction, by assuring good contact between ballast and fixture frame; (3) radiation, by providing adequate surface areas. He mentioned the increasing complexity of the heat dissipation problem being brought about by the increasing tendency to mount fixtures at the ceiling, and especially with reference to fixtures recessed into the ceiling.

Plastics

"Plastics for Lighting" were discussed by Mr. Sprankle, who pointed out that this relatively new industry still has many problems to be solved and much experience yet to be gained. In general terms, he described the different thermoplastics currently being manufactured for one purpose or another, and stated that the "ideal plastic" for lighting applications would not cost more than 25c to 30c per pound, would have a coefficient of linear expansion approaching that of metals; would have unlimited colorability and color stability; would be self-extinguishing or at least slow-burning; and would have other desirable qualities. Mr. Sprankle said that the nearest approach to this ideal now is methyl methacrylate (of which "Lucite" is an example) at about 75c a pound, but that for economic and other reasons polystyrene is the most commonly used. He mentioned that injection molding and compression molding are the common methods of forming plastic shapes, but that the extrusion process is the latest promising technique.

Street Lighting

Planning.—Whereas commercial, industrial, and sports lighting applications may range up to 200 footcandles, and special jobs up to 1000 footcandles or so, Gene Ray of the Holophane Company, Inc., New York City, stated that "the street lighting engineer faces a problem which usually starts at a high of perhaps 3 footcandles and goes from there down." He pointed out that proper street lighting is a matter of obtaining proper discernment of objects, and is directly affected by many local conditions entirely outside the control of the lighting application engineer.

Mr. Ray emphasized the necessity for freedom from glare, which can be obtained from controlled shielding and by regulation of mounting height, stated that glare is a dozen times greater at a 10-foot mounting height than at 20 feet. He pointed out also

that the matter of pavement brightness is a neglected but very important factor in effective street lighting application design, and that this in its extremity involves consideration and planning of the materials used for street surfaces.

Equipment. — In describing new developments in street lighting equipment, Mr. Spaugh pointed out that satisfactory street lighting would be economically impossible if it were not for the development and use of reflectors, refractors, etc. to direct light to points where needed and to reduce its wastage on areas where it is not wanted. He emphasized the element of pavement brightness to reveal objects by silhouette as being "the only economical way of accomplishing effective street lighting, since it is economically unfeasible to provide sufficient flood lighting to reveal objects by direct illumination."

The use of the long-arc mercury lamp in a horizontal position for street-lighting purposes was described by Mr. Spaugh. In such installations, a controlling electromagnet is mounted above the arc tube, the magnetic field of which acts to repel the arc downward and thus hold it in the center of the lamp tube. For ideal control of the operation of street lamps, Mr. Spaugh mentioned the use of a photo cell device to provide localized group or individual control on the basis of the need for light, rather than the time of day.

Future. — "On the basis of 'adequacy,' essentially all existing street lighting is obsolete and eligible for replacement or modernization," according to Mr. Clerke, "even though the older installations may have been 'adequate' when originally installed." In emphasizing the public importance of street lighting, Mr. Clerke paralleled Winston Churchill's famous wartime statement "never in human conflict have so many owed so much to so few" with the statement "for no phase of traffic accident prevention can so many be indebted for so much for so small a cost." In support of this statement he quoted statistics:

1. In 1947, with some 37,000,000 automobiles registered in the United States, there was a total of 32,000 fatal traffic accidents, of which 20,000 were at night.

2. In 1941, peak year of traffic fatality accidents, some 34,000,000 were registered in the United States, accounting for a total of some 40,000 fatal traffic accidents, of which 23,000 were at night.

3. The average overall economic loss is some $80,000 per traffic death, taking into account all factors, such as lost time, medical costs, wages, property damage, etc.

4. Sixty per cent of fatal traffic accidents occur at night when only 30 per cent of the traffic is moving.

On this basis, Mr. Clerke stated emphatically that "proper street lighting can be sold as an investment and not as an operating cost." He called attention also to the recently announced fact that in the United States during 1948 some $1,342,973,000 were collected as taxes on automobile fuel representing some 30 billion gallons. He raised the question of the proportion of these funds actually being used for street and highway development, and urged that more effective efforts be made to cause the expenditure of an appropriate proportion of such funds for adequate street and highway lighting.

School Lighting

Engineer's Viewpoint. — Mr. Kilpatrick, in speaking to his topic "An Engineer Looks at Modern Lighting," approached the problem pretty much from a quantitative point of view. He pointed out that by 1953 there will be 6½ million more pupils in public schools than in 1949, and called for constructive and aggressive action to assure proper consideration of lighting requirements incidental to the design and construction of the new school facilities that will be required.

Mr. Kilpatrick mentioned the importance also of improving existing school facilities, especially with reference to the matter of classroom lighting. He emphasized that, "having reached the position where adequate levels of footcandles can be supplied efficiently from available equipment, it is quite appropriate that more and serious attention and study be given to light control and "brightness engineering." Mr. Kilpatrick commented upon the confusion and adverse effects which arise from a wide divergence of individual interpretations of good lighting practice, and urged that for the good of all concerned this situation should be remedied.

Educator's Viewpoint. — In speaking to the topic "An Educator's Viewpoint on Modern School Lighting," Dr. Souder specifically urged that "good lighting must be sold as a 'package' embracing the entire classroom environment in terms of benefit to the user, rather than being sold as fixtures, lumens, or footcandles ... we are concerned with both the quantity and the quality of light, and should be just as careful to avoid too much as too little, especially in the re-lighting of old buildings. ... We should hear more about the control and use of daylight. ... There is not enough school money currently available to solve the lighting problem even when the problem is recognized, therefore it becomes necessary to reduce the complexity and cost." Dr. Souder expressed a strong personal preference for totally indirect lighting, and a strong desire for a "simple unobtrusive fixture which is simple and easy to maintain." He expressed the hope that the "fluorescent lamp could be developed along the lines of the silver bowl incandescent lamp, which should simplify the fixture and its maintenance."

Dr. Souder commented strongly on the customer confusion which results from the divergent and often conflicting recommendations received from different persons or companies representing the lighting industry. He pointed out that, "with 90 per cent of the schools in the United States more than 10 years old, 50 per cent of them more than 20 years old, the problem of school re-lighting is an extensive one which well merits the best thoughts of the lighting profession as well as the school authorities."

Ways and Means. — In discussing "Ways and Means of Achieving Better School Lighting" Mr. Bradley suggested that most of the confusion about which the two preceding speakers had complained, could be avoided by a general adherence to the basic principles set forth in the Recommended Practices. This was recommended as being to the benefit of all concerned in spite of minor individual differences of opinion.

Mr. Bradley strongly suggested that "the I.E.S. should further implement the Recommended Practices by developing procedures for the practical application of the good ideas represented, for example, in the American Standard Practice for School Lighting. ... Further, for example just what is to be told to the public about fluorescent versus incandescent lighting or other points of conflict in individual or promotional opinion?"

Mr. Bradley laid great stress on the need for simplicity in maintenance requirements of lighting fixtures, and described in detail an extensive school lighting application that has been made in Denver, Colorado, school system as a part of a general rehabilitation program. He presented a series of graphs designed for predicting maintenance costs of lighting fixtures.

Great Lakes Region Meets at Rochester

The Great Lakes Region held a two-day Technical Conference at the Hotel Sheraton in Rochester, N. Y. May 23-24. The formal registration for Rochester Conference was 94 men and 14 women, with local guests and visitors bringing the gross attendance up to approximately 190.

At the opening general session, Regional Vice-President, W. A. Stannard, called attention to the membership growth in the region — from 989 in October, 1948 to 1,180 in April, 1949 as representing the steadily increasing interest in the field of illumination and in the activities of the Society. He paid tribute to the value of the support given to the work of the Society by its sustaining members, and urged that a wider effort be made through the various sections and chapters to increase the roster of sustaining members by extending the opportunity for participation to qualified candidates.

Both Mr. Stannard and President Tayler laid stress again on the importance of local state registration as professional engineers for all Society members having engineering qualifications. Sections and Chapters were urged to keep this matter active locally. In his exposition of the scope and nature of Society organization and activities, President Tayler urged that "we not get into the habit of talking too much to ourselves ... with its growing pains of activity, IES boundaries cross many other fields where mutual knowledge and understanding would be highly advantageous ... the need for the dissemination of dependable information is greater now than ever before." President Tayler urged a broader and more effective use of the wide range of Society publications available, ranging from Committee Reports and recommended practices to the monthly ILLUMINATING ENGINEERING. President Tayler encouraged local section and chapter members to cooperate in broadening the service rendered by ILLUMINATING ENGINEERING by reporting interesting and outstanding local lighting installations. President Tayler urged that continuing efforts be made to promote the establishment of qualified courses in illumination subjects at more of the recognized engineering colleges.

PROGRAM

The Conference program at Rochester was composed of morning and afternoon sessions on both days. The social program included an informal group luncheon the first day, special activities for visiting women guests, and came to a climax with the President's reception, banquet and dance Monday evening, May 23, with B. A. Thomas of the Western New York Section acting as toastmaster for an informal entertainment program. A very small number of persons stayed over for the third day in Rochester to take advantage of industrial inspection trips offered by the local committee.

W. J. Wilford of the Ohio Valley Section presided over the first technical session, Monday morning, for the following program:

1. "Opening of the Conference," L. C. Twichell, General Chairman of the Regional Conference.
2. "Introduction of the President" by W. A. Stannard, I.E.S. Regional Vice-President.
3. "Illumination Levels" by H. L. Logan of the Holophane Co., Inc., New York, N. Y.
4. "Design Aspects of Louverall" by Wentworth M. Potter of the General Electric Co., Cleveland, Ohio.

The Monday afternoon session was under the chairmanship of T. S. Harmon of the Central New York Chapter, and included the following:

1. "Color Control Demonstration" by R. Gillespie Williams of the Color Control Corporation, New York, N. Y.
2. "The American Standard Practice for School Lighting, Its Preparation, Use and Value" by Russell C. Putnam, Case Institute of Technology, Cleveland, Ohio.
3. "Ultra-High Speed Photography and Light Sources" by Dr. Brian O'Brian of the University of Rochester, Rochester, N. Y.
4. "Daylight Brightness Control in Classrooms" by Henry L. Blatner, Architect of Albany, N. Y.

Chairman of the Tuesday morning session was W. H. Kahler of the Cleveland Section. The four items on the program were:

1. "Lighting for Safety and for Traffic Control" by H. L. Osborne, Traffic Engineer for the City of Buffalo, N. Y.
2. "Muscle Tension as an Index of Visual Effort" by Professor M. E. Bitterman, Cornell University, Ithaca, N. Y.
3. "Performance of Fluorescent Lamps on Leading Power Factor Circuits" by R. N. Thayer and A. Brownell of the Lamp Development Laboratory, General Electric Co., Cleveland, Ohio.
4. "Lighting a Sports Arena" by L. T. Kirwin, Electrical Engineer with A. M. Kinney Associates, Cincinnati, Ohio.

"Planned Lighting" was the theme of the concluding session Tuesday afternoon, under the chairmanship of L. R. Nall of the Michigan Section. The first of the seven items of program was contributed by the Rochester Section, the other six being presented by personnel of the Michigan Section. The program:

1. "Planned Lighting in Rochester" by Vincent Mitchell of the Rochester Gas & Electric Corp., Rochester, N. Y.
2. "The Planned Lighting Program in Action" by Robert Frank of the Detroit Edison Co.
3. "New Methods of Serving and Lighting of Used Car and Parking Lots" by Fred Ready of the Detroit Edison Co.
4. "Redesigning of All Factors Contributing to Classroom Lighting" by Leslie D. Lyon of the Consumers Power Co., Jackson, Michigan.
5. "The Last Word in Ladies' Apparel Store Lighting" by Herbert J. Miller of the Detroit Edison Co.
6. "Application of Ultra Violet Light Sources to a New Market" presented by Hugh Archer of the Detroit Edison Co. in the absence of Robert Bandfield of the same company.
7. "Light and Color in Utility Substation" by L. E. Mueller of the Detroit Edison Co.

COMMITTEE PERSONNEL

The people responsible for the success of the Rochester Conference were:

General Chairman: Lester Twichell, Rochester Chapter.

Secretary: Donald Vincent, Central New York Chapter.

Treasurer: Norman Kridel, Rochester Chapter.

Program: T. D. Wakefield (Chairman), Franklin Detwiler, Cleveland Section; William Lampinen, Central New York Chapter; Ralph Enghouser, Ohio Valley Section; Leslie Lyon, Michigan Section; Robert Jordon, Henry Osborne and Fred Vanderlinde, Rochester Chapter.

Registration: Walter Parkes (Chairman), Harold Baumer and George Butler, Rochester Chapter.

Decorations: Earl Miller (Chairman), Hugh Crowley, Paul Hank and Walter Erskine, Rochester Chapter.

Publicity: Ray Siedle (Chairman), Donald Erskine, John Gienger, Homer Locke, and Floyd Owen, Rochester Chapter.

Hotel: Fred Schmidt (Chairman), William Barelay, Vincent Mitchell, Carl Pollack, and Edward Zdenek, Rochester Chapter.

Entertainment: Harold Linder (Chairman), David Carroll, Russell Rankin, Frank Schmidt, and George Spillane, Rochester Chapter.

Local Attendance: William Bennett, Rochester Chapter.

Ladies: Miss Melrose Franklin, Mrs. William Bennett, Mrs. Homer Locke, Mrs. Walter Parkes, Mrs. Ray Siedle, Rochester Chapter.

Illumination Levels

H. L. Logan did not undertake to predict or to specify illumination levels with reference to any given kind of task, but spoke in general terms, reviewing "something of what is being done by the many who are studying the problem of illumination levels." He pointed out that all presently available methods for determining desirable levels of illumination for any given complexity of task are "only visual performance methods and do not take into account other important factors, such as personnel comfort." Mr. Logan showed curves illustrating the conflicting results and the irreconcilibility of the three principal present methods (the Moon and Spencer "Dalos"; the Luckiesh threshold-of-visibility method; and the Weston method, a function of size of detail of task and comparison of task with background). Mr. Logan expressed the hope that "some day the differing results from these three different methods can be resolved into one composite practical method." He demonstrated the use of the Holophane "Calculux," which is a circular slide rule type of calculator based on the Weston method. In discussion, George Ainsworth of New York commented upon the fact and effect of the 8-to-1 change in diameter of the iris of the human eye in adjusting from darkness to light, a 64-to-1 change in area and hence in the amount of light passing through the iris. Mr. Ainsworth suggested a range of from 100 to 200 footeandles as "an effective range for comfortable and efficient use under conditions simulating a daylight sky light."

Louverall

"Louverall is the most rapidly growing method of lighting application," according to Wentworth M. Potter. In discussing the louverall design details, Mr. Potter gave something of a digest of his paper, Part II of which appears in the June issue of Illuminating Engineering. Emphasizing its "high degree of flexibility and capability of providing high footeandle levels with only moderate brightness, Mr. Potter sees "a tremendous future for louverall, not necessarily only as a complete ceiling but also in sections according to design requirement ... not as a panacea but as a new resort to be integrated with other illuminating equipment to produce the desired results on any given job ... it offers great future potential for thoughtful application." Mr. Potter took issue with the statement made in an article on "Fallacy of the Louverall Ceiling" published in the March issue of Illuminating Engineering. This precipitated an extended and animated informal discussion which continued until well after the session. (For subject, see pages 381-84 of the recent June issue of IE.)

Color Control

Color effects, and the methods and equipment for their production and control, were described and demonstrated by R. Gillespie Williams. Emphasizing the point that there is no such thing as "simple white light," he discussed and demonstrated the importance of proper balance of colors in bringing out a true visual picture, especially in such instances as in space lighting and merchandise display lighting. Through the use of 3-dimensional objects, living models, on which light was projected in varying intensities in two or more directions simultaneously from banks of white, red, green and blue lights, Mr. Williams demonstrated what he estimated to be some 500 different colors and many times that number of color effects. All of the light sources were under the control of a specially developed electronic control machine through which any desired individual color or color combination could be varied at will by turning a dial in much the same fashion as one would tune a radio set. The device enabled color effects to be adjusted at will, arranged in preset sequences, and either changed or accurately repeated at the will of the operator by noting the dial settings.

One of the equipments demonstrated was a special spotlight containing white, red, green and blue lamps, the output of which could be so blended and varied through the use of the electronic control device as to provide some 500 hues of light in the form of a directional beam without the need of changing any gelatins or color filters

School Lighting

The history, background and current significance of "The American Standard Practice for School Lighting" was discussed by Professor R. C. Putnam, Case Institute of Technology, who was a member of the I.E.S. School Lighting Committee and the American Standards Association Committee preparing the 1948 edition. Professor Putnam pointed out that the evolution of this important publication started back in 1918 with the issuance of the first I.E.S. school lighting code. By 1923, the American Standards Association had taken up the matter and initiated cooperative efforts toward the development of an American standard practice, an activity in which I.E.S. has been continuously active. Professor Putnam explained that whereas the 1948 edition was technically a revision of the 1938 edition, it actually had been completely re-written and enlarged to embrace the newest concepts and equipment, and that its significance lay in the fact that it represented an up-to-date meeting of the minds of architects, engineersh, educators, the medical profession, the ophthalmologists and others vitally interested in the all-important topic of effective school lighting. Professor Putnam emphasized the value of the 1948 edition as "a practical guide for school architects, educators, and administrators in the ten billion dollar rehabilitation program currently facing American schools."

Ultra-High-Speed Photography

In discussing "Ultra-high-speed photography and light sources," Dr. Brian O'Brian described and demonstrated a new type of high-speed motion picture camera and explained its application to the study of such ultra-high-speed events as flash and spark light sources. The camera operates about a million times faster than the standard motion picture camera—so fast in fact that a two-foot strip of film from it will provide, after processing, film for an hour's motion picture projection at standard projector speed. The device is the outgrowth of what was developed originally as a "streak camera," a sort of optical oscilograph for the study of certain spark light sources.

The camera is capable of making ten million exposures per second and was rated by Dr. O'Brian as being much too fast for the study of so slow a phenomenon as a lightning stroke. The fast shutter action required by the camera is provided by two parallel aluminum wires 0.0025 inch in diameter; the passage of 5,000 amperes through each of these wires instantaneously causes them to be drawn together by mutual attraction at an acceleration of about a million times gravity—fast action for any shutter. Such a high-speed camera requires an exceedingly high intensity of illumina-

tion, stated by Dr. O'Brian to be some 200 million lumens — representing about 5,000 HP—obtained through the use of a type FP 524 lamp operated at 4,000 Volts.

Daylight in Classrooms

The architectural and structural means of accomplishing "daylight brightness control in classrooms" with reference to a new Grammar School building at Clarksville, N. Y. were described by Mr. Henry L. Blatner. The two especially interesting features of the project were (a) the departure from prosaic established design and (b) the educational methods used in "selling" a nonconventional design to the town's people upon whose vote depended the funds for the project. The classrooms are arranged in tandem in a single story structure so oriented as to place the large clear-glass window-walls to the North (in spite of the prevailing custom of easterly orientation) with the interconnecting corridor along the south side. Classrooms are larger than normal, being 28 x 30 feet. On the outside of the building along the north side above the windows a wooden louver-type sky screen reduces sky-glare in the rooms. The wall from this louver to the roof is glass block which redirects the entering daylight upward against an upward sloping ceiling. Additional daylight enters through clear glass windows along the top of the south wall between the roof of the corridor and the roof of the classroom, also protected from direct sunlight by a louver-type sky screen. Supplemental electric lighting is provided by individual louvered flash units. The building cost was quoted by Mr. Blatner as being $14.33 per sq. ft., compared with costs ranging from $18.00 to $25.00 per sq. ft. for the conventional type of school building. The project was "sold" to the voters through a series of informal meetings held in homes and elsewhere throughout the community under the auspices of the School Board and addressed by the architect. Attendance at these meetings was kept low, about 20 persons, to provide plenty of opportunity for informality and individual discussion. The program was highly effective.

Light for Traffic Safety

Buffalo has under way a street lighting modernization program the ultimate objective of which is to replace all of the old-style pedestal units which "illuminate buildings, porches, shrubbery, and everything but roadways," according to Mr. H. L. Osborne, in discussing "Lighting for Safety and Traffic Control." It is planned that conversion will be made to pendant-type units hung from arms which will place them over the pavement and at a height of about 25 feet. Mr. Osborne reported that a survey of Buffalo's 650 miles of street showed that 80 per cent of all traffic fatalities occurred on just 72 of those miles. He stated that the lighting rehabilitation program has been planned accordingly, stating further than "Buffalo now has more than 8 miles of good I.E.S.-recommended street lighting and no fatalities or even serious injuries have occurred in that area. . . . Proper street lighting is as much a part of street and highway development as are drains, fire hydrants, or even the pavement itself."

Light Versus Human Effort

In discussing "Muscle Tension as an Index of Visual Effort," Professor M. E. Bitterman gave an informal progress report covering the preliminary result of a Navy research project currently underway at Cornell University. The project represents the psychologist's approach to the question of illumination levels with relation to the efficiency of human beings performing different kinds of tasks. The essence of Professor Bitterman's experimental procedure is as follows: test subjects are male students ranging from 20 to 28 years of age, having vision "normal or corrected to normal." Each subject undergoes the test procedure for 4 one-hour periods per week for two successive weeks. Under test, each subject, "with electrodes pasted all over him" sits in an electrically shielded room under "homogeneous lighting conditions," and views a paper passing across an aperture at normal reading range at a speed which requires the subject to make and record a decision every two seconds as to whether or not typewritten characters successively appearing on the moving paper are "same" or "different." The electrical impulses set up in the subject's muscular tissues by these actions are noted and recorded by observers. So far, these test cycles are being run alternately under illumination levels of 6 footcandles and 18 footcandles, from incandescent sources. Professor Bitterman in evaluating preliminary data, stated that there was good correlation between illumination levels under homogeneous conditions and the human energy used for seeing. Out of the averages of the ten subjects, a marked difference was shown in the nervous muscular tension from the 18 footcandle level as compared with the 6 footcandle level. The protracted discussion which followed Professor Bitterman's talk indicated both the encouraging results obtained from his work, as well as the limitations it was felt existed in the number of points investigated and the lack of investigation of footcandle levels found in present practice. Dr. Bitterman assured the audience that the work would continue and more comprehensive results would be forthcoming.

Fluorescent Lamp Performance

Mr. R. N. Thayer presented the Brownell-Thayer paper "Performance of Fluorescent Lamps on Leading-Power-Factor Circuits." He pointed out that the popular twin-lamp unit fixture for 40-watt and 85/100-watt fluorescent lamps commonly uses a twin circuit which puts one of the lamps on a leading power factor and the other lamp on a lagging power factor circuit, the combination giving the reduction in cyclic flicker, and overall power factor "to unity," which makes the unit popular. Mr. Thayer pointed out that the importance of this topic lay in the facts that "fluorescent lamp performance is critically dependent upon ballast design . . . certain differences of performance of lamps appear to be inherent on these two circuits, and so are not subject to the ballast designer's choice, lamps on lead circuits generally start more slowly than on lags; shift less in current wattage and light output, with fluctuations in supply voltage; stay operative on lower values of supply voltage, or on momentary dips; warm up to full light output faster; and start under more adverse conditions of supply voltage and ambient temperature." Therefore, he recommended that "to obtain the quality and performance built into a fluorescent lamp by its manufacturer, the ballast designer and manufacturer must be particularly careful on lead circuits to meet ballast design recommendations which the lamp manufacturer is best able to determine."

Sports Lighting

"The Lighting of the Court Cincinnati Garden, and Indoor Sports Arena," was described by Mr. L. T. Kirwin. The building is 325 x 287 feet, 90 feet high from floor to roof, accommodates a 200 x 85 foot activities arena and viewing stands containing seats for 12,000 persons. There is an associated parking lot accommodating some 2,400 cars. The building was designed to accommodate activities

ranging from a boxing match to a full-sized circus and required lighting facilities accordingly. Because of the size of the total load (some 450 hp) and the distribution distances involved, the lighting in the building is served through five 480-volt 3 phase feeders which terminate on local load filters where the voltage is stepped down to the 120/208-volt three-phase four-wire system. The design intensity for maintained illumination over the main 200 x 85 foot arena area is 75 footcandles. This is achieved by the use of 3-unit clusters suspended to a level of 30 feet above the floor and using 1000-watt lamps; provision is made for the use of 1500-watt lamps. Provision also is made for the use of luminaires at the 75-foot level for such activities as circuses which require the additional ground current. The lighting intensity provided in corridors, stairways, and undeveloped storage areas averages 5 footcandles; in dressing rooms and backstage areas, 15 footcandles; in toilet rooms, 10 footcandles. For stage lighting and theatrical effects, provision is made for Klieglights and high-intensity spotlights. The design provides for a flexibility in the arrangement of lighting for special activities; for example, the provision of a lighting level in the boxing ring in excess of 250 footcandles. In the 650,000 square feet adjacent parking lot, a total of 46 1500-watt floodlights mounted on twelve 45-foot poles provide a calculated average intensity of one footcandle.

Planned Lighting

The final session of the Rochester Conference was devoted to the subject "Planned Lighting," featuring a presentation of six items by personnel of the Michigan Section under the general title "The Michigan Lighting Workshop."

In the maxim, "All for one and one for all," lies the root of the phenomenal success of planned lighting effort in Rochester. According to Mr. Vincent Mitchell, exceptionally fine cooperation has been developed in Rochester among all parties concerned in the matter of proper lighting, including the electrical contractor, the wholesaler, the architect, the customer, and the power company. The Rochester experience represents one of the outstanding examples of the growing consciousness of interdependence among the autonomous elements of the electrical industry, a matter of broad significance and importance.

Introducing the Michigan Section group of items, Mr. Robert Frank described "the planned lighting program in action" in his territory. He, too, brought out the importance of full fledged cooperation of the several elements of the industry, ranging from the architect with his designed plans, through the power company with its facilities for plans and suggestions, and the electrical contractor also for the planning as well as the installation. Mr. Frank emphasized the "landslide action" wherein one good lighting job done in a well chosen area serves as a nucleus and stimulant for others.

Mr. Fred Ready reported that as a result of the floodlighting of Briggs Stadium and the introduction of night baseball in Detroit, the power company received numerous requests for the lighting of parking lots in the area. Study of this problem served to focus attention on the fact that the power company's long standing rule against the mounting of both metering and lighting equipment on its poles had a tendency to result in expensive and otherwise unsatisfactory floodlighting installations. Protracted study of the problem in conference with customers, electrical contractors, and maintenance personnel resulted in a change in power company policy. Under the new policy, the company will install a pole up to 35 feet in height including a 96-inch clock arm and service connection, free of charge. Ordinarily the lighting fixture would be approximately 24 feet above ground level, requiring a 35-foot pole. The contractor then will install his equipment, governed by certain limitations designed to enable power company personnel to climb the pole at any time free of obstruction. Power company's service is brought in 7 inches from the top of the pole; the crossarm is mounted 3 feet below this to allow room for personnel to work at the service loops; units are spaced on the crossarm to allow clearance around the pole at all times; the service entrance then continues on down the pole to a meter cabinet mounted about 5 feet above the ground line, goes through the switching equipment and time clock and back up to the flood lights. For a nominal fee, the power company will periodically clean floodlight reflectors and replace lamps. As a result of the activity stimulated by this new policy, according to Mr. Ready, a recent installation at one used-car lot provides from 50 to 75 footcandles.

In discussing "the redesigning of all factors contributing to classroom lighting," Mr. L. D. Lyon described the situation in a city of some 10,000 population involving some 17 school buildings. He described the cooperative work done incidental to the transition of a typical classroom from an installation of 6 opal-glass units giving from 5 to 8 footcandles on the desk and from 2 to 3 on the porch to a modern system. The new system utilizes 21 fluorescent units in the average standard classroom, three rows of six plus one in each row at right angles at the end of the row to light the board. This system is designed to give and maintain level of about 40 footcandles at the center of the room and from 28 to 30 at the side, after several months of operation. The average cost of some $600 per room applied to the entire city, represented a cost of some $250,000. In May, the voters of this city approved a $4,000,000 school modernization project including the re-lighting plus another $150,000 for other modernization requirements.

The re-lighting of a retail shop dealing in women's apparel was described by Mr. H. J. Miller in discussing his topic "The Last Word in Ladies' Apparel Store Lighting." A general illumination of some 85 footcandles for the 2,600 square feet of floor area is provided through a louverall ceiling utilizing slimline fluorescent lamps. A three-foot cavity above the louverall was painted black by the architect's specification to hide pipes and other unsightly items; the effect is a slightly bluish cast to the ceiling light. Accent lighting for merchandise is obtained through a combination of swivelier units and flush ceiling fluorescent panel unit. Extensive use was made of mirrors, shadow boxes, and display niches. Reflectors were not used over the slimline ceiling lights.

Ultraviolet energy is beginning to play an important part in the lighting and utility industry, at least in Detroit, according to Mr. Hugh Archer of The Detroit Edison Co., who presented Mr. Robert Bandfield's paper in Mr. Bandfield's absence. Mr. Archer reviewed the rather extensive work that has been done on this subject in the company's laboratories. He pointed out that "during the war years, ultraviolet energy played an important part in many applications for product protection, and in some cases for air sanitation. Further, that in the post-war period many new and useful applications of this energy have been made, and undoubtedly many more will be developed in the future." Typifying industrial installations, Mr. Archer described an ultraviolet installation made

by a food packer to reduce practically to the vanishing point what had been a costly loss from mold of imported olives. Mr. Archer discussed other installations and also described and demonstrated an accurate and effective instrument developed in his company laboratory for the defection and calibrated indication of the intensity of ultraviolet irradiation to which either product or personnel may be exposed at any location or under any condition.

The importance and practical value of "Light and Color in Utility Substations" were discussed at some length and illustrated by Mr. L. E. Mueller. Supplemented by "before" and "after" pictures, Mr. Mueller demonstrated how good lighting in power plants could very effectively improve both the morale and the operating efficiency and accuracy of personnel. This is a long neglected field.

LOCAL MEETINGS

Cleveland Section

Extension meetings outside of home cities have provided extraordinarily successful programs for a number of Sections and Chapters. Such a field trip to Youngstown, Ohio was a feature of a recent Cleveland Section program, in which 97 members formed a motorcade to the steel city for an inspection tour of the Youngstown Sheet and Tube Company. Speaker at the dinner meeting following the inspection was John Saunders, sales executive of General Fireproofing Co., who spoke on "Light Reflecting Office Equipment."

Apparently encouraged by the success of their inspection trip in April, the Cleveland Section again planned a field tour to inspect the new all-weather approach lighting system at the Cleveland Airport on May 10. Planned as a joint meeting with the Society of American Military Engineers, the trip included a dinner meeting at the Airport's Skyway Restaurant, during which W. A. Pennow, airport lighting specialist with the Westinghouse Electric Corp., spoke.

In order to inspect the effects of the new approach lighting system as the pilots themselves see it, arrangements had been made with the American Airlines to bring to the meeting a Convair Flagship with full crew, for a 30-minute inspection trip over the airport and Greater Cleveland. Some 130 members and guests attended.

The new all-weather approach lighting system at Cleveland, paired with similar ones at Newark and New York, establishes the first leg of an all-weather airway. Flights between Cleveland and the New York area are now operating over this airway.

Connecticut Section

Another exceptional field trip organized as an I.E.S. meeting was the inspection of submarine lighting held April 28 by the Connecticut Chapter. Arrangements were made with the U. S. Navy Submarine Base at New London, Connecticut for a seven-hour program which included complete inspection of a Navy submarine, dinner at the famous Wagon Wheel, with a welcome by Capt. T. L. Wilmon of the Sub Base; inspection of the Medical Research Vision Laboratories; and a talk by Lt-Commander Deans Farnsworth on "Advances in Color and Illumination Conditioning." The program was an outstanding success, both in its interest to lighting people, and in the opportunity afforded for an inspection available under no other auspices. Some 175 members of the Connecticut, New York, and New England Sections made the trip.

Pittsburgh Section

A day out was taken by most Pittsburgh Section members recently for an inspection trip to Irwin, Pa., to visit the factory of the Pittsburgh Reflector Co. there. Busloads left Pittsburgh at 11:15 in the morning, and returned late in the afternoon. The Section had organized the entire cavalcade, including luncheon for the group at the Jacktown Hotel in Irwin.

New York Section

New York City's international airport "Idlewild" was also the object of an I.E.S. inspection trip when Section members toured this famous field on May 19, as part of its regular May meeting. Chartered coaches were arranged to take members to the field, where the party was conducted in airport buses over the entire field to inspect the many outstanding lighting installations in service there.

A dinner meeting at the Dobbs House Restaurant located in the ultra-modern Airport Terminal Building, was also a feature of the meeting. Speaker was John M. Kyle, Chief Engineer of the Port of New York Authority, who spoke on "Lighting of Airports."

Chicago Section

Still another outstanding inspection trip was the I.E.S. Tour to the University of Illinois, arranged by the Chicago Section on May 6. This too was an all-day affair, attended by 110 students and Chicago Section members. Buses left Chicago for Champaign, Illinois at 10 in the morning, returning at midnight after an extraordinarily interesting program at the University.

In addition to a complete inspection of the Illinois campus and new Electrical Engineering Building, the program included demonstrations and talks in the University's new Lighting Demonstration Room, Photometric Laboratory, and Lighting Research Laboratory. Dinner was enjoyed at

CLEVELAND SECTION, I.E.S. and The Society of American Military Engineers enjoyed a plane ride as part of their May 10th joint meeting at Cleveland Airport. The purpose of the meeting was to inspect the new All-Weather Approach Lighting System, the newest aid to bad weather flying.

the Illini Club at the University, following which Glenn Boyd, Chairman of the Chicago Section, presented the University of Illinois a check for $500 for the two Illumination Scholarships for the next year.

Southern California Section

One of the largest meetings ever held on the west coast was conducted May 4 by the School Lighting Committee of the Southern California Section, under the direction of T. A. Esling, the committee's Chairman. Close to 300 people attended.

Devoted exclusively to school lighting, and in particular as recommended by the I.E.S. American Standard Practice of School Lighting, the program was presented in two parts and in panels under the four general headings contained in the School Lighting Practice. A very comprehensive treatment was given the subject at each panel, by leading speakers from the educational, architectural, medical and lighting fields.

Part I of the program covered a general review of the School Lighting Practice, including:

(a) General Conditions; School Tasks; Quantity and Quality of Illumination, discussed by J. W. Howard, General Electric Co.

(b) Natural Lighting; General, Natural Lighting Controls, discussed by Foster K. Sampson, Electrical and Illuminating Engineer.

(c) Artificial Lighting, General Lighting Systems; Chalkboards; Special Lighting Requirements, by Ralph Crump, U.C.L.A.

(d) The Economic Factors of School Lighting; General, Cost Analysis, Maintenance, by F. J. Rohring, California Edison Co.

Part II of the program featured an open forum discussion of school lighting with a special panel discussion group led by Henry Wright, architect, Kistner, Curtis and Wright; Ralph Crump of the University of California and Los Angeles; J. W. Howard; A. I. Benedict, San Diego Gas and Electric Co.; F. J. Rohring, Southern California Edison Co.; Arthur A. Knoll, Business Manager of the Long Beach Schools; Foster K. Sampson, Consulting Engineer; Dr. Edward I. Goodlaw, President of the Los Angeles County Association of Optometrists; Dr. Warren Wilson, President of the Los Angeles Society of Ophthalmology; Bruce Hawk, Coordinator of Special Service, Los Angeles County Schools; E. R. C. Billenbeck, Los Angeles Board of Education; and Herbert Fifield, Architect for the San Diego City Schools.

The Section was fortunate in having very distinguished representation from each of the participating fields. Recognized leaders in their respective professions took part in the panel discussions. Questions were directed specifically to members of the panel and such was the interest developed that it was finally necessary to close the meeting with many questions still uncovered. Many interesting and controversial phases were brought up for discussion, sometimes as many as three or four members of the panel contributing to one argument.

Such a committee-sponsored meeting could well initiate a pattern for future meetings of the open forum type. The meeting was considered in the Southern California Section to be one of their most successful meetings, and by the other professional people attending, a most instructive project.

Utah Chapter

A joint meeting of the Utah Chapter of I.E.S. and the Intermountain Electric Association was recently held in Salt Lake City, with unusual success. Held as a luncheon meeting at the Newhouse Hotel, the meeting featured "New Developments in Lighting," by Charles R. Long, Pacific Coast District Engineer for the Westinghouse Electric Corp.

Oregon Section

Another joint meeting, of especial interest to decorators and architects, was planned by the Oregon Section recently, under the joint auspices of I.E.S. and the Portland Electric Club. The program featured "Functional Lighting for the Home," by Miss Myrtle Fahsbender of Westinghouse Electric Corp., Bloomfield, N. J., who is also one of the Directors of the national I.E.S.

Georgia Section

The Georgia Section of I.E.S. has sponsored the formation of a Residence Lighting Forum in Atlanta, which is now operating successfully as part of the Georgia Section's several projects. The new Forum's first organizational meeting was held on March 18, with Miss Ruth Morris of the Georgia Power Co., acting as temporary chairman. Some 44 members and guests of the new organization met for dinner, to hear a presentation of the purpose and aims of the Forum. About 42 applications for membership were received forthwith, with several more mailed in after the meeting. During the meeting, committees were appointed for nominating permanent officers and establishing By-Laws for the Atlanta Residence Lighting Forum, and plans announced for the Forum's future meetings.

Subsequent meetings held by the Atlanta Forum included a joint meeting with the Georgia Section in April, featuring "Good Home Lighting for Any Income" by Edith Buchholtz, home lighting consultant with the Westinghouse Lamp Division, Bloomfield, N. J., and a meeting in May on "The Use of Glass in Home Lighting," by J. H. Murrah, architectural lighting specialist of the Georgia Power Co.

CHICAGO SECTION Chairman, Glenn B. Boyd (right) recently presented a check for $500 to the University of Illinois to be added to a $2500 Scholarship Fund previously donated by the Section. Receiving the check is Prof. William L. Everitt (center), head of the Electrical Engineering Department. At left is Prof. J. O. Kraehenbuehl, advisor to the newly-formed I.E.S. Student Branch at the Univ. of Illinois.

SOUTHERN CALIFORNIA School Lighting Panel, conducted by the Section's School Lighting Committee. Left to right: Herbert Fifield, Architect, San Diego City Schools; A. I. Benedict; General Electric Co., San Diego; E. R. C. Billerbeck, Los Angeles Board of Education; Henry Wright, Chairman Advisory Committee, School House Planning; Jack Rohring, Southern California Edison Co.; Bruce Hawk, Coordinator, Special Service, Los Angeles County Schools; Dr. Warren Wilson, ophthalmologist; T. A. Esling, Chairman of the Southern California Section's School Lighting Committee; Ralph Crump, U.C.L.A.; Arthur Shildroth, Pasadena Schools; J. W. Howard, General Electric Co.; Arthur Knoll, President, National Association of School Business Managers, Long Beach; Dr. E. I. Goodlaw, optometrist; Foster Sampson, Consulting Engineer. *Photo by Hawthorne.*

Michigan Section

Another Residence Lighting Forum started this year, is functioning successfuly in conjunction with the operation of the Michigan Section. Headed by Mary Taepke of Detroit Edison, as Chairman, the Forum has now held five excellent meetings, with an average attendance of some 60 people per meeting. Starting with a first meeting in November, the Michigan Residence Lighting Forum has featured programs on "Traditional Design" by Bruce Bradshaw, prominent Detroit decorator; "Study Conditions in the Home" by Mary Webber of General Electric Co., Cleveland; "The Four Degrees of Residential Lighting," by Edith Buchholtz of Westinghouse Lamp Division, Bloomfield, N. J.; "Round Table Discussion on the House of Charm," led by Anthony Fodell of the Madison Electric Co., Detroit and Chairman Taepke and a home lighting skit enacted by local talent within the Forum; and "Light Sources Used in the Home," by Ted Brown of the General Electric Co., Cleveland, followed by an indoor picnic.

Twin City Section

Midwestern Regional Vice-President Edwin J. Lauth was guest of honor at the Annual Spring Dinner Dance held recently by the Twin City Section at the St. Paul University Club. Carl T. Bremicker, Past-Chairman of the Twin City Section presided as Toastmaster. Speeches were short and to the point, though nothing further, even short speeches, could have added to the success of the party, acknowledged by all to be terrific. Notables at the head table included Joseph Kvalsten, retiring Chairman of the Section; Robert H. Hamilton, Chairman-Elect; and their ladies, Helen Kvalsten, Laura Bremicker and Josephine Hamilton.

Cornhusker Chapter

Some of the most ambitious, and most successful, local meetings held by I.E.S. groups year after year, have been the quarterly Lighting Conferences sponsored by the Cornhusker Chapter and the Iowa Section. Each meeting, held for a number of years now, has been considered the most important conference to be held in that territory. Attendance is invariably large; groups travel from several states to attend; the programs attain Regional Conference importance.

The most recent one was held April 22 in Sioux City and constituted a full day and evening program featuring major speakers in lighting development.

C. R. Tracy was General Chairman of the Conference, which was organized along Regional meeting lines with responsible chairmen and committee projects. The program was planned under the direction of M. B. Mendenhall, Chairman. Social activities, which included mass attendance at a ball game at Soos Park was under the direction of J. J. Bertsch. E. J. Pardun had charge of the Reception Committee; M. W. Casler and R. W. Murphy the Hotel Committee; M. W. Torrey and H. V. Haviland in charge of Publicity; and E. J. Pardun, Hubert Palmer, Jr., Mark E. Lee and H. V. Haviland, handled the Inspection Tour which was part of the program.

The program attracted an extensive local press and was honored with the presence of the Mayor of Sioux City, Dan J. Conley, who delivered the opening address.

Speakers participating in the Spring Lighting Conference of the Cornhusker Chapter included:

George C. Mittauer, Chapter Chairman.

Benjamin S. Benson, Benjamin Electric Manufacturing Co., Des Plaines, Ill.

Fred E. Guth, Vice-President of the Edwin F. Guth Co., St. Louis, Mo.

G. T. Morrow, Vice-President of Curtis Lighting Inc., Chicago, Ill.

C. I. Brady, Manager Commercial Engineering, Sylvania Electric Products Inc., Salem, Mass.

In addition to the excellent technical papers, the Conference program in-

GEORGIA SECTION establishes Residence Lighting Forum. Shown here is the group of 44 members and guests attending a special organizational meeting on March 18, to establish the Forum's officers, By-Laws and future program.

TWIN CITY luminairies Carl T. Bremicker, Past Chairman, Edwin Lauth, Regional V-P, and J. Kvalsten, retiring Chairman, at dinner honoring V-P Lauth.

cluded an inspection tour of outstanding commercial lighting installations; the Des Moines vs Sioux City ball game; a social hour reception for all delegates at the Martin Hotel; and an evening banquet and dance. Some 150 local members and guests participated.

Ohio Valley Student Branch

The Charter for the second Illuminating Engineering Society Student Branch was presented to this group at the University of Cincinnati April 29, by the Great Lakes Regional Vice-President W. A. Stannard. A special meeting and banquet was held for the occasion.

The program, which was attended by 18 Ohio Valley Section members and 19 students and faculty members was presented at the Student Union Building on the University of Cincinnati Campus. The Ohio Valley Chairman, William J. Wilfert, acted as toastmaster and introduced Mr. Edwin Knauft, President of the Cincinnati Electrical Association who addressed the group on the subject of "I.E.S. and Industry."

Regional Vice-President Stannard, in his presentation address, outlined the history of the I.E.S. and its aims and accomplishments through the years. He urged that the students of this embryo group take an active interest and participation in the Society's affairs and projects.

Dean C. A. Joerger of the College of Engineering, University of Cincinnati, welcomed the infant group to the campus and advised them to continue their initial enthusiasm in accomplishing the aims and ideals of the Society. He was sustained in his remarks by R. J. Dickason of the Electrical Department, Faculty Advisor of the student branch. Mr. Dickason also outlined the development of the student organization.

The Charter was accepted by R. A. Jenkins, who is Chairman of the newly-formed group.

Much of the development of this new student branch can be credited to J. A. Kristof of the Ohio Valley Section who was instrumental in organizing the students and urging their making application for a charter. The entire membership of the Ohio Valley Section is extremely interested in furthering the development of this second Student Branch, and have already offered their assistance in successfully accomplishing any projects which they may assume.

Milwaukee Chapter

A lighting conference of special consequence was featured in Milwaukee May 19, the first of such meetings to be sponsored annually by the Milwaukee Chapter. Some 150 I.E.S. members in the midwest area attended the all-day sessions.

A series of very valuable symposiums on various phases of lighting were featured in the program, with speakers of national prominence. Guest of honor at the Milwaukee Conference was I.E.S. President Lee E. Tayler, who addressed the luncheon session.

Significant technical subjects were presented on the program. Beginning at 8:30 in the morning and continuing well into the evening the Conference program featured:

Opening Discussion Session — R. R. Knoerr, Chairman, Milwaukee Chapter.

"What's New in Light Sources," by Carl Jensen, Westinghouse Electric Corp.

"How Do We Make These New Sources Work—Trouble Shooting," by Charles L. Amick, General Electric Co., Nela Park.

Luncheon Session—I. L. Illing, Toastmaster.

"I.E.S. Today and Tomorrow," by L. E. Tayler, President of I.E.S.

"Problems in Store Lighting Design," by Kenneth C. Welch, Grand Rapids Store Equipment Co.

"New Concepts in School Lighting," by Carl J. Allen, General Electric Co., Nela Park, Cleveland, Ohio.

"Correlation of Brightness Ratios and Decoration," by W. A. Kahler of Westinghouse Electric Corp., Cleveland, and J. M. Meacham, Sherwin-Williams Co.

"Where Do We Go From Here," by I. L. Illing, Wisconsin Electric Power Co., Milwaukee, Wisconsin.

Outstanding event in the evening program was a trip to the Blatz Brewing Co. Hospitality Room. Lighting in this unusual room is one of its outstanding features, exceptional in comfort and original design and is considered to be one of the most modern installations in the midwest. The main dining room is lighted with an indirect cove of gold colored lamps. The center of the high ceilinged room has architecturally designed indirect lighting, the color of which may be varied

OHIO VALLEY Student Branch receives I.E.S. Charter at special meeting and banquet held at the University of Cincinnati. Participating were: (Seated left to right) H. C. Blackburn, Vice-Chairman, Ohio Valley Section; W. J. Wilfert, Chairman, Ohio Valley; W. A. Stannard, Regional V-P; Edwin Knauft, President, Cincinnati Electrical Assn. (Standing) J. F. Voelker, Manager, Ohio Valley Section; R. J. Dickason, Faculty Advisor; R. A. Jenkins, Chairman, Student Branch; N. L. Weckstein, Secretary, Student Branch; R. W. Brown, Secretary, Ohio Valley Section; Dean C. A. Joerger; R. Champlin, Treasurer, Student Branch; J. A. Kristof, Ohio Valley Section.

MILWAUKEE Lighting Conference sponsored May 19 by the Milwaukee Chapter of I.E.S. featured prominent speakers in a full-day of technical sessions. Speakers' table at the Blatz Hospitality Room is shown at left. At right, some of the 150 I.E.S. members participating included R. W. Staud, Past-President of the Society, E. Aik, Chairman of the Reception Committee, and L. E. Tayler, I.E.S. President.

by switching in different colors of fluorescent lamps.

A featured speaker at the evening session of the Milwaukee Conference, not listed in the technical program was a "Balkan official" (A. A. Engelhard who m.c.'d the proceedings) who gave his version of "What I Think of Illuminating Engineering." While the Balkan's whiskers were more distingué than his very U.S.A. tie, his presentation was greatly appreciated.

All sessions, however, proceeded on a clock-like schedule, a popular feature. Chairman for the morning session was H. F. Ilgner, Bureau of Electric Service, City of Milwaukee, and for the afternoon session, J. C. Staff, Jr., Staff Electric Co.

Local members heading the various planning committees were: For the program — E. H. Grieb, Wauwatosa, Wisconsin, C. N. Laupp, Wisconsin Electric Power Corp. The Registration Committee was under the direction of T. H. Markworth, General Electric Supply, as Chairman and E. M. Reid, Milwaukee. Planning and promotion of the conference was handled by E. H. Aik, Daylight and Duplexalite, Milwaukee, as Chairman, and A. J. Von Burg, Wisconsin Power and Light Co., George Kammerer, Wisconsin Public Service Co., of Wausau, C. Lagemann, Wisconsin Public Service of Green Bay, T. H. Markworth, General Electric Supply, J. Peterson, Graybar, Milwaukee, Ed. Davis, Westinghouse Electric Supply, H. Grosh, Westinghouse Electric Corp., and Willis Murphy, consultant of Milwaukee.

ABOUT PEOPLE

Effective June 1, **Frank E. Brown** became a representative of the Day-Brite Lighting, Inc. in the states of Connecticut and Rhode Island, according to a recent announcement. Formerly Merchandising Manager for the Globe Lighting Products Co., Brooklyn, N. Y., Mr. Brown entered the lighting industry in 1938 when he joined the General Electric Co. Construction Materials Division. He is an active member of the New York Section of I.E.S., serving on a number of local committees.

William L. Lane, manager of the industrial sales department of Sears Roebuck Co. for 27 years, has joined the Lamp Division of Westinghouse Electric Corp., as a special sales representative, with headquarters in Chicago.

George V. Ellis, formerly with the General Electric Co. offices at Birmingham, Alabama, has been named head of the new South Central Sales District recently established by General Electric to serve the states of Mississippi, southeastern Louisiana, eastern Arkansas and western Tennessee. Headquarters of the new district will be in Memphis, Tenn.

Also appointed to a sales district management is Robert V. Corning, who will head the Ohio Valley Sales District of General Electric, in Cincinnati, Ohio. Mr. Corning is being transferred from the company's Lamp Department at Nela Park.

Douglas B. Clark has been appointed by General Electric Co. to head the new district to be known as the Florida Sales District, with headquarters in Tampa, Florida. The new district under Mr. Clark's direction will include all of Florida and the southeastern tip of Georgia.

E. W. Gutelius has been named to direct advertising and sales promotion for the lamp and fixture divisions of Sylvania Electric Products Inc., it was recently announced. He will be in charge of all promotional activities covering incandescent and fluorescent lamps, and fluorescent lighting fixtures and auxiliary parts. Formerly assistant sales promotional manager for the lamp department of the General Electric Co., Mr. Gutelius has had wide experience in this field.

From a recent report on Local Activities from **L. L. Holladay**, Member Emeritus, it is interesting to note that even in his retirement this eminent member is continuing his service to I.E.S. Dr. Holladay, now retired from General Electric Lighting Research Laboratories is I.E.S. Local Representative for Charlottesville, Virginia. His continuing work in this area includes the encouragement of new memberships in I.E.S. of a number of prominent professional men in Virginia, activity with the University of Virginia in the Society's interests, contact with the local engineering and professional societies, and intial steps in the organization of an amalgamated engineering group with the university and neighboring towns of the Piedmont section of Virginia.

New Educational Center Planned for Pittsburgh

Construction has begun on a new and modern building to house the Westinghouse Educational Center. Located on a 10-acre plot at Brinton Road, East Pittsburgh, the three-story structure will face the Ardmore Boulevard interchange of the new Penn-Lincoln Parkway. It is planned to provide facilities for all advanced educational programs carried on by the Westinghouse Electric Corporation. A. C. Monteith, president of the Westinghouse Educational Center and vice-president of the company, reported that the building contract provides for substantial completion within nine months. He indicated that the new Center will meet an urgent need for more adequate educational facilities and will house the activities of the evening graduate study program now being carried out in cooperation with the University of Pittsburgh, as well as those of the Westinghouse graduate student training course.

OBITUARY

Preston S. Millar

One of the Society's most distinguished members has been lost to it in the death on June 17 of Preston S. Millar. Mr. Millar was one of the active founders of the Illuminating Engineering Society, a Charter Member, and in 1913 its eighth President. The Society's highest honors have been awarded to Mr. Millar in recognition of over forty years of invaluable service to its aims. In 1945 he was elected a Fellow of I.E.S., and in the same year was awarded the I.E.S. Gold Medal "for meritorious achievement conspicuously furthering the profession, art, or knowledge of illuminating engineering.

Mr. Millar's activities and services for nearly half a century to illuminating engineering have been so numerous as to make it difficult to list them in a reasonable space. To name a few, however, he was co-developer, with the late Dr. C. H. Sharp, of the Sharp-Millar Photometer which helped provide more accurate measurements of illumination and thus advanced the scientific basis of lighting practice.

Throughout the years he has exercised a strong influence on the advance of street lighting knowledge and practice. Mr. Millar was the first to point out the importance of silhouette vision in the lighting of streets, and his paper and demonstration on this phase at the 1910 Convention in Baltimore had a marked influence on the thinking of engineers. He was the Society's first chairman of the Committee on Street Lighting, later serving as a member of that committee for some 25 years.

Continuously throughout the existence of the Society, Mr. Millar has been active in its affairs, serving in various offices on the Council body, and almost continuously on one or more of the Society's committees. He is the author of numerous papers published in the Transactions and ILLUMINATING ENGINEERING — almost one a year for every year of the Society's existence.

Probably Mr. Millar's greatest accomplishment has been the building up of the Electrical Testing Laboratories, of which he was director and President at the time of his death. It was with the Electrical Testing Laboratories that he entered the lighting industry in 1897 as a tester of incandescent

Preston S. Millar

electric lamps, from which he rose through the various ranks to become President of the organization. When a sudden emergency struck the institution, he successfully led it through a reorganization into an employee owned company. Under his direction "ETL" has stood as one of the leading institutions of its kind and a very important factor in the application of the ideals and technical thought of the Illuminating Engineering Society. Probably no other institution has done more toward putting lighting on a scientific basis of measurement; in this the influence of Mr. Millar was a real factor.

Mr. Millar was also an active member of the U. S. National Committee of the International Commission on Illumination, serving as its President from 1936 to 1948. At the I.C.I. Congress in Paris last summer, Mr. Millar was a prominent delegate.

He was a member also of the American Council of Commercial Laboratories (President 1937-1939), the New York Electrical Society, Inc. (President 1943-1944), and of the National Society for the Prevention of Blindness of which he was currently a Vice-President. He was a Fellow of the American Physical Society, the American Association for the Advancement of Science and a member of the American Institute of Electrical Engineers, American Optical Society, Association of Consulting Chemists and Chemical Engineers and of the American Society for Testing Materials.

Mr. Millar whose home was at the Buckingham Apartments, Scarsdale, N. Y., is survived by his widow, Mrs. Lily Bradford Bayliss, a daughter, Mrs. Katherine LeBaron Floeting, and two sons, Bradford P. and Robert V. Millar.

Fleur-O-Lier Index System Classifications Expanded

Three new shielding classifications were added to the Fleur-O-Lier Index System by action of the Fleur-O-Lier Advisory Board at a meeting held in Chicago recently. This enlarges the number of shielding zone classifications from 19 to 22.

The classifications 0-20 and 0-30 were added for fixtures with side shielding of less than 10° but having end shielding of either 20° or 30° down from the horizontal plane.

The inclusion of these two new shielding classifications was to accommodate more easily fixtures intended for use in long corridors where end shielding is more important than side shielding.

Also, a new 45-45 shielding classification was added to other fixtures with square egg-crate type of louvers and resulting 45° shielding in both directions, which type of shielding is used frequently in school lighting practice as well as other fields.

The Fleur-O-Lier Index System was announced early this year and has been of particular value in the classification of present lighting fixtures in relation to their performance. The Index System has two separate functions. It is a simple method by which the specifier may indicate the essential illuminating performance desired for any installation. It also serves as a means of identifying fluorescent lighting fixtures on the basis of their illuminating performance, enabling the purchaser of lighting equipment to get the precise fixtures recommended.

Shielding is but one of the four phases of lighting performance covered in the Fleur-O-Lier System. Others are: Type of light distribution, brightness in the shielded zone and type of mounting.

Revised Fleur-O-Lier charts including the three new shielding classifications are available from Fleur-O-Lier Manufacturer, 2116 Keith Bldg., Cleveland 15, Ohio.

Georgia Recognizes Illumination As Separate Branch

At its April meeting, the Georgia State Board of Registration for Professional Engineers and Land Surveyors approved the classification of Illuminating Engineer. This action resulted from recent efforts of the Georgia Section of the Illuminating Engineering Society.

The State of Georgia adopted the model Registration Law in 1943 defining the title "Professional Engineer." This model law has been adopted by

most states and allows the local board to specify the several classifications under which a professional engineer may be licensed to practice.

The Board of Managers of the Georgia Section, I.E.S., at its meeting held December 3, 1948 appointed a committee to petition the state board for recognition. This committee was headed by Joe B. Browder, Southern Regional Vice-President and Atlanta Division Lighting Engineer of the Georgia Power Company. Others on the committee were: L. Ralph Bush, Consulting Electrical Engineer; Howard L. McKinley, Associate Professor of the Georgia Institute of Technology; George M. Normandy, Architectural Engineer. All of the committee are members of I.E.S.

The Committee formed a petitioning letter, appearing in person before the Georgia State Board of Registration on March 11, 1949, and presented the petition. At the next meeting of the State Board on April 8th, the Board voted favorably on the petition and a letter from R. C. Coleman, Joint Secretary of the State Examining Boards, was sent to Mr. Browder notifying him that the classification of Illuminating Engineer had been approved.

The Georgia Section of I.E.S. is proud of the accomplishment of Mr. Browder and his committee and feels that, by the precedent set by this official action on the part of the State of Georgia, a real contribution has been made to the profession of Illuminating Engineering, as recognition in other states will probably follow.

Theatre Lighting Committee Now Underway

The I.E.S. Committee on Theatre Lighting held its first organization meeting in New York, May 17, to outline a program expected to culminate in valuable data in this field. As a first step in providing an authoritative guide to this phase of lighting, the committee will attempt to survey and codify fundamentals of theatre lighting. They have set up a study program with the idea of calling upon each committee member in different parts of the country to study locally, feeding the accumulated experiences and information to the central committee.

Attendance at this initial meeting included: C. M. Cutler, S. G. Hibben, H. A. Kliegl, Edward Rambusch, Ben Schlanger, R. Gilespie Williams, and F. M. Wolff. Other members of the committee are E. Braun, J. R. Cravath, T. Fuchs, J. S. Hamel, James McCullough, H. D. Sellman, George Smedberg and D. Staehle, Jr.

Society Represented at President Truman's Highway Safety Conference

The third annual President's Highway Safety Conference, called by President Truman, was held June 1, 2 and 3 in Washington, D. C. The appalling increase in highway accidents involving property damage and fatalities since the end of gasoline rationing following World War II, caused government agencies to explore the possibilities of a nation-wide program in an effort to increase highway safety.

The first Conference was called in 1946 by President Truman, wherein the statistics on accident rate in the various states were presented to some 2,000 delegates representing all phases of the motor industry, professional societies, legislature, and highway engineering. A second Conference was called in 1947, at which time an action program was developed involving public education and uniform laws and ordinances covering the use of streets and highways. This year another conference was held, again attended by over 2,000 delegates, for the purpose of discussing specific elements of highway control in various committees and divisional conferences in which situations peculiar to certain areas of the country could be adequately discussed.

The Illuminating Engineering Society was represented at this Conference by L. E. Tayler, President, and Dr. Roland M. Zabel, Vice-Chairman of the Committee on Street and Highway Lighting. The Society has an important function in this action program, and at the meeting of Council on June 8, 1949, President Tayler submitted a resolution offering to President Truman the full support of the Society's manpower and facilities in the cause of furthering safer use of streets and highways.

The Society's Resolution to the President of the United States read:

Whereas: The increasing use of our streets and highways by vehicular traffic since the close of World War II and following the end of gasoline rationing, has resulted in an appalling increase in death, injury and property damage, and —

Whereas: President Truman, realizing the need for an Action Program of Traffic Safety and Control, called into convention the first President's Highway Safety Conference in 1946 for the purpose of developing said Action Program which Conference again convened in 1947, and —

Whereas: The third Conference was called on June 1, 2 and 3, 1949 to which the Illuminating Engineering Society was invited to send two delegates and was duly represented by the President of the Society and Dr. Rolland M. Zabel, Vice-Chairman of the Street and Highway Lighting Committee and —

Whereas: The objectives of the Society through its Committees have contributed and will continue to contribute to the safer use of streets and highways through the medium of developing knowledge and techniques in the application of lighting —

It is Hereby Resolved, that the Illuminating Engineering Society offer to the President of the United States the full support of its facilities and manpower as an active and interested agency in the vital cause of street and highway safety.

This resolution having been duly signed by the President of the Society and duly submitted to Council, has, on this 8th day of June, 1949, been unanimously adopted.

BOOKS AND PAMPHLETS

An illustrated engineering bulletin on the installation, operation, and testing of fluorescent lamp ballasts has been announced by the General Electric Co. Known as GET-922B, it may be secured from that company at Schenectady 5, N. Y. In addition to basic information, there are sections on starters, ballasts for d-c operation, ratings and similar related data.

In the hope that it will spur action toward solving the problem of out-of-date and non-uniform local regulations among industries, the American Standards Association has issued an analysis of the question: "How can nationally recognized standards legally be used in state laws and local ordinances?" Entitled "National'ly Recognized Standards in State Laws and Local Ordinances," the booklet contains four principal papers. These show how lack of technical requirements increases costs to industry and to the public and reduces public safety. They analyze the need for legal methods that will permit wide-spread use of nationally recognized standards; summarize the present status of the "adoption by reference" method; and discuss the legality of several methods that have been followed in using national codes and standards as a basis for local regulations. The booklet is a report by ASA Committee Z56 on Model Laws and Ordinances and is available from the American Standards Association, 70 East 45th St., New York 17, N. Y.

A booklet titled "Good Schools Are Your Responsibility" has been prepared by the class of 1949 of the

School of Architecture, Tulane University, New Orleans. The display project on school improvement undertaken at Tulane and described in the booklet covers also the importance of lighting in good school design.

For those who can read French, an interesting book on infrared for photography is available from Cie de Lamps, c/o General Electric Co., Schenectady, N. Y. *Photographie à l'Infrared* by Maurice Deribere is published entirely in the French language. It is, however, a most complete treatise on this subject, and should be valuable reference material. The 175-page book contains some 132 illustrations and graphs, and much basic data on infrared photography.

Color is How You Like It, a new booklet reporting the results of a comprehensive study by the Sylvania Electric Products Inc. on the effect of artificial light on color has recently been announced. Based on an analysis made by four observers, all experienced in color work and recognition, the booklet is designed to provide factual information for homemakers, interior decorators, designers, architects and consultants. Results of the study are expected to furnish a simple method of determining which of the six different tones of white light now available—incandescent, warmtone and warmtint fluorescent, 3500K white, soft white, 4500K, and daylight fluorescent—are best suited to different colors of paints and fabrics. The booklet is available from the Commercial Engineering Dept., Sylvania Electric Products Inc., 500 Fifth Ave., New York, N. Y.

Election of New I.E.S. Officers

At a meeting of the Council held June 8, 1949, the report of the Committee of Tellers was presented, giving the results of the recent election of officers for the coming year, beginning October 1, 1949. The following have been elected to the offices indicated:

GENERAL OFFICERS

President — Charles H. Goddard, Sylvania Electric Products, Inc., Ipswich, Mass.

Vice-President—Samuel G. Hibben, Westinghouse Electric Corp., Bloomfield, N. J.

General Secretary—A. Homer Manwaring, Philadelphia Elec & Mfg. Co., Philadelphia, Pa.

Treasurer—Everett M. Strong, Cornell University, Ithaca, N. Y.

Directors (until Sept 1952)—Duncan M. Jones, Curtis Lighting Co. of Canada, Ltd., Montreal, Que., Canada; Rudolph E. Biesele, Jr., 3241 Amherst St., Dallas, Texas.

Regional Vice-Presidents — J. S. Schuchert, Duquesne Light Co., Pittsburgh, Pa.; F. A. Covington, Box #171, San Antonio, Texas; G. F. Dean, Toronto Hydro-Electric System, Toronto, Ont., Canada; J. B. Browder, Georgia Power Co., Atlanta, Ga.

BRITISH COLUMBIA SECTION

Chairman — F. D. Bolton, F. D. Bolton, Ltd., Vancouver, B. C., Canada. *Secretary* — S. C. Smith, Canadian Westinghouse Co., Ltd., Vancouver, B. C., Canada. *Board of Managers*—H. J. Ashbee, R. M Campbell, A. Freeman, L. Robson, E W. Thompson.

CAPITAL SECTION

Chairman — J. P. Bachman, Jr., General Electric Co., Washington, D. C. *Vice-Chairman*—G. W. Clark, Sylvania Electric Products, Inc., Washington, D. C. *Secretary*—R. P. Teele, 3713 Jenifer St., N. W., Washington, D. C. *Board of Managers* — O. P. Clenver, L. M. Endres, Dorothy Nickerson, C. S. Woodside.

CHICAGO SECTION

Chairman—Ralph R. Cheney, Westinghouse Lamp Division, Chicago, Ill. *Vice-Chairman* — Clarence B. Pederson, Illinois Bell Telephone Co., Chicago, Ill. *Secretary*—Robert R. Lusk, 6645 Stewart Ave., Chicago, Ill. *Board of Managers*—Carl A. Basedow, Glenn G. Boyd, D. W. Fuller, Louis Licastro.

CLEVELAND SECTION

Chairman — C. L. Amick, General Electric Co., Nela Park, Cleveland, Ohio. *Secretary*—F. E. Mueller, 1296 Nicholson, Lakewood, Ohio. *Board of Managers* — C. F. Daugherty, M. A. Mortensen, D. W. Rowten, W. P. Werner, C. G. Wing.

CONNECTICUT SECTION

Chairman — Victor J. Ouellette, Hartford Electric Light Co., Hartford, Conn. *Vice-Chairman* — Randall M. Hendricks, So. New England Telephone Co., New Haven, Conn. *Secretary* — Robert S. Rogge, The Miller Co., Meriden, Conn. *Board of Managers* — Kenneth E. Estler, Lawson Fullerton, Charles W. McCormick, Wesley N. Warnes.

GEORGIA SECTION

Chairman—J. H. Murrah, Georgia Power Co., Atlanta, Ga. *Vice-Chairman*—H. M. Horton, General Electric Co., Atlanta, Ga. *Secretary* — (Miss) Reta Lee, Georgia Power Co., Atlanta, Ga. *Board of Managers* — C. L. Cannon, R. A. Corvey, R. B. Fogarty, R. J. Kuzell.

HEART OF AMERICA SECTION

Chairman—Harold R. Weibel, General Electric Co., North Kansas City, Mo. *Vice-Chairman*—John M. Weir, W. T. Foley Electric Co., Kansas City, Mo. *Secretary* — Frank I. Feagans, Kansas City Power & Light Co., Kansas City, Mo. *Board of Managers*—Harry Baker, Benjamin F. Cook, Arthur L. Harris, Ray E. Perry.

IOWA SECTION

Chairman—C. O. Christensen, Crescent Electric Supply Co., Dubuque, Iowa. *Vice-Chairman* — W. D. Barnhizer, Iowa Electric Light & Power Co., Cedar Rapids, Iowa. *Secretary*—H. P. Wilson, Electrical Institute of the Tri Cities, Rock Island, Ill. *Board of Managers* — Ned W. Elliott, J. C. Gehan, Ben O. Horton, A. E. Johnson.

MICHIGAN SECTION

Chairman — Arthur P. Hammerstrom, 141 Massachusetts Ave., Highland Park, Mich. *Vice-Chairman* — Charles C. Munroe, 22555 Gregory Ave., Dearborn, Mich. *Secretary*—Alfred C. Sangster, 10961 Nottingham, Detroit, Mich. *Board of Managers* — Benjamin F. Avery, John E. Dawson, George D. Hanna, August G. Ofenstein.

MONTREAL SECTION

Chairman — A. H. Mendel, Gray Electric Co., Montreal, Que., Canada. *Secretary* — D. F. Davis, Northern Electric Co., Ltd., Montreal, Que., Canada. *Board of Managers* — R. E. Hendershot, A. H. Johnson, F. P. Labey, E. E. Morris, E. G. Smith.

NEW ENGLAND SECTION

Chairman — Willard Allphin, Sylvania Electric Products, Inc., Salem, Mass. *Secretary* — Norman E. Tiechurst, Cambridge Electric Light Co., Cambridge, Mass. *Board of Managers* —George B. Almy, Fred D. Crowther, Frederick J. Lawson, K. A. Sawin, J. L. Steffenhagen.

NEW YORK SECTION

Chairman—Leon T. Johnson, Public Service Electric & Gas Co., Newark, N. J. *Secretary*—Carroll L. O'Shea, General Electric Co., New York, N. Y. *Board of Managers*—Ralph R. Brady, Max Gysi, Girvan Higginson, Ernest H. Salter, Hugh P. Scott.

NORTHERN CALIFORNIA SECTION

Chairman—Dan M. Finch, University of California, Berkeley, Calif. *Vice-Chairman*—Sol Cohn, California Electric Supply Co., San Francisco, Calif. *Secretary*—Robert W. Thunen, Sylvania Electric Products Inc., San Francisco, Calif. *Board of Managers* —A. Anderberg, Samuel H. Hazelton, Jr., William R. Major, Jr., H. H. Robison.

OHIO VALLEY SECTION

Chairman — Harry C. Blackburn, 111 W. Hudson Ave., Dayton, Ohio. *Vice-Chairman* — Robert W. Brown,

Cincinnati Gas & Electric Co., Cincinnati, Ohio. *Secretary*—J. F. Voelker, 2650 Cedarbrook Dr., Cincinnati, Ohio. *Board of Managers*—J. R. Fuller, H. E. King, Eugene A. Norvell, R. J. Schulte.

OREGON SECTION

Chairman—J. Daniel Webster, Pacific Power & Light Co., Portland, Ore. *Vice-Chairman*—J. G. Galarneau, Packard-Malloy Inc., Portland, Ore. *Secretary*—Charles M. Gates, Portland General Electric Co., Portland, Ore. *Board of Managers*—Ellsworth R. Fletcher, Robert E. Lange, Paul L. Norstrom, Ray W. Preston.

PHILADELPHIA SECTION

Chairman—Fred M. Pyle, Gill Glass & Fixture Co., Philadelphia, Pa. *Vice-Chairman*—E. F. Lafond, Delaware Light & Power Co., Wilmington, Del. *Secretary*—R. S. Bucher, 436 Robinson St., North Tonawanda, N. Y. *Board of Managers*—F. R. Adair, R. M. Hoot, T. W. Lauer, Percy B. Thorne.

PITTSBURGH SECTION

Chairman—A. R. Hampsey, Jr., Duquesne Light Co., Pittsburgh, Pa. *Vice-Chairman*—C. M. Crysler, General Electric Co., Pittsburgh, Pa. *Secretary*—Nelson Warner, Westinghouse Electric Corp., Pittsburgh, Pa. *Board of Managers*—G. C. Dankmeyer, G. H. Maize, Harry Restofski, C. B. Swann.

PUGET SOUND SECTION

Chairman—Henry R. Huber, 3018 45th Ave., S. W., Seattle, Wash. *Vice-Chairman*—H. A. Gardner, 4173 42nd, N. E., Seattle, Wash. *Secretary*—Clarence A. Scheyer, Puget Sound Power & Light Co., Seattle, Wash. *Board of Managers*—D. T. Carter, Charles C. Fields, H. C. Hall, K. E. Hollingsworth.

ST. LOUIS SECTION

Chairman—Melton Johns, Graybar Electric Co., Inc., St. Louis, Mo. *Secretary*—Williams H. Simms, Union Electric Company of Missouri, St. Louis, Mo. *Board of Managers*—Phil V. Brown, E. L. Ehret, T. P. Gleeson, Carter Lewis, Henry Poehling.

SOUTHERN CALIFORNIA SECTION

Chairman—Oscar W. Meissner, Dept. of Water & Power, Los Angeles, Calif. *Secretary*—S. H. Simonsen, Westinghouse Electric Supply Co., Los Angeles, Calif. *Board of Managers*—Louis D. Black, Jr., Arthur E. Booth, Roy E. Dahlin, Hugh X. Sheeter, Leonard W. Towner.

SOUTHWESTERN SECTION

Chairman—W. H. McAdams, George E. Anderson Co., Dallas, Texas. *Vice-Chairman*—N. O. Reed, Dallas Power & Light Co., Dallas, Texas. *Secretary*—W. T. Kimery, Dallas Power & Light Co., Dallas, Texas. *Board of Managers*—L. T. Anderson, John G. Felton, Jr., Irving Rosvold, H. B. Sudekum.

TORONTO SECTION

Chairman—Frank G. Reed, The Hydro-Electric Power Commission of Ontario, Toronto, Ont., Canada. *Secretary*—D. W. Patterson, Amalgamated Electric Corp., Toronto, Ont., Canada. *Board of Managers*—D. C. Fielding, D. J. McKenzie, Taylor H. Quipp, Allen G. V. Smith, Bertram A. Wilson.

TWIN CITY SECTION

Chairman—Robert Hamilton, 5336 Drew Ave., S., Minneapolis, Minn. *Secretary*—A. B. Hallaway, Northern States Power Co., Minneapolis, Minn. *Board of Managers*—G. William Frederick, J. O. Kvalsten, Paul T. Owens, F. T. Tillemans, R. A. Weidt.

WESTERN NEW YORK SECTION

Chairman—Raymond P. Connors, 778 Starin, Kenmore, N. Y. *Vice-Chairman*—William B. Campbell, Buffalo Niagara Electric Corp., Buffalo, N. Y. *Secretary*—William A. Biser, General Electric Co., Buffalo, N. Y. *Board of Managers*—Francis B. Burke, Edwin S. Burrows, B. A. Thomas, R. Bruce Thompson.

NEW MEMBERS

At the meeting of the Council held on June 8, 1949, the following were elected to membership:

ALAMO CHAPTER

Associate Member:

Duce, Thomas E., Scott Electric Co., Corpus Christi, Texas.

BALTIMORE CHAPTER

Associate Members:

Bozman, Gordon L., Dorman Electric Supply Co., Baltimore, Md.

Burdette, John C., Jr., Egli & Compf, Inc., Baltimore, Md.

Meredith, Henry G., Industrial Power Equipment Co., Baltimore, Md.

CAPITAL SECTION

Associate Members:

Goodman, Benjamin, National Electric Wholesalers, Washington, D. C.

Snow, Posey L., Garden City Plating & Mfg. Co., Chicago, Ill.

CAROLINAS CHAPTER

Members:

Knapp, Charles N., General Electric Co., Charlotte, N. C.

Robinson, R. K., Robinson Electric Co., Inc., Charlotte, N. C.

Associate Members:

Greene, G. W., Jr., South Carolina Electric & Gas Co., Columbia, S. C.

Jordan, G. W., Gaston Electric Co., Gastonia, N. C.

Hall, John H., Hall & Company, Inc., Spartanburg, S. C.

CHICAGO SECTION

Members:

Hanagin, Ward E., City of Chicago, City Hall, Chicago, Ill.

Peirce, G. R., Prof., University of Illinois, Urbana, Ill.

Associate Members:

Chambers, Elmer J., The Frink Corp., Chicago, Ill.

Lennon, Victor A., 207 N. Wabash Ave., Chicago, Ill.

Lewin, L. Ernst, Garden City Plating & Mfg. Co., Chicago, Ill.

Martin, William J., Efengee Electric Supply Co., Chicago, Ill.

Student Members:

Berry, Ralph L., University of Illinois, Urbana, Ill.

Bringman, Donald B., University of Illinois, Urbana, Ill.

Casolari, Dante, University of Illinois, Urbana, Ill.

Dahl, Warren K., University of Illinois, Urbana, Ill.

Hart, Alvin L., University of Illinois, Urbana, Ill.

Jefferis, Robert A., University of Illinois, Urbana, Ill.

Leginski, Bruno J., University of Illinois, Urbana, Ill.

Makulec, Alfred, University of Illinois, Urbana, Ill.

McClusky, Val G., University of Illinois, Urbana, Ill.

Vannice, Warren T., University of Illinois, Urbana, Ill.

CLEVELAND SECTION

Member:

Bos, John, The Austin Co., Cleveland, Ohio.

Associate Members:

Nies, Alan F., General Electric Co., Nela Park, Cleveland, Ohio.

Rice, Randall H., Westinghouse Electric Corp., Cleveland, Ohio.

CONNECTICUT SECTION

Member:

Washburn, E. F., Fletcher-Thompson, Inc., Bridgeport, Conn.

Associate Member:

Barton, Leon N., 81 Plymouth St., New Haven, Conn.

Student Member:

Ballard, R. E., The Connecticut Light & Power Co., New Britain, Conn.

CORNHUSKER CHAPTER

Associate Members:

Fifer, Thomas J., Westinghouse Electric Supply Co., Omaha, Neb.

Maynard, D. J., The Korsmeyer Co., Lincoln, Neb.

Palmer, H. J., Jr., Sioux City Gas & Electric Co., Sioux City, Iowa.

Vahl, W. H., Crescent Electric Supply Co., Sioux City, Iowa.

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SUSTAINING MEMBERS

Acme Electric Corp.
Cuba, N. Y. *J. A. Comstock*

Admiral Lamp Manufacturing Corp.
2430 So. Ashland Ave., Chicago, Ill. *F. Schwartz*

Advance Transformer Co.
1122 W. Catalpa Ave., Chicago 40, Ill. *Hirsch Epstein*

Alabama Power Co.
Birmingham, Ala. *George L. Morris*

All Bright Electric Products Co.
3917-25 N. Kedzie Ave., Chicago 18, Ill. *Max Klein*

Amalgamated Electric Corp., Ltd.
384 Pape Ave., Toronto, Ont., Canada *D. W. Patterson*

American Concrete Corp.
4727 North Lamon Ave., Chicago 30, Ill. *J. W. Lewis*

American Fluorescent Corp.
5407 Broadway, Chicago, Ill. *William Rusnak*

American Sterilizer Co.
Erie, Pa. *Horace Wm. Alexander*

Appleton Electric Co.
1701-1739 Wellington Ave., Chicago 13, Ill. *Nils A. Tornblom*

Arkansas Power & Light Co.
Simmons National Bldg., Pine Bluff, Ark. *Max Sudduth*

The Art Metal Co.
1814 E. 40th St., Cleveland 3, Ohio *George E. Glatthar*

Artistic Lamp Manufacturing Co., Inc.
395 Fourth Ave., New York 16, N. Y. *Myron Perlmutter*

Bausch & Lomb Optical Co.
Rochester 2, N. Y. *David L. Williams*

Benjamin Electric Mfg. Co.
Des Plaines, Ill. *John H. Waterbury*

Blue Ridge Glass Corp.
Kingsport, Tenn. *J. H. Lewis*

Board of Water and Electric Light Commissioners
116 W. Ottawa St., P.O. Box 570, Lansing 3, Mich. *John D. Malnight*

Boston Edison Co.
39 Boylston St., Boston 12, Mass. *R. B. Brown, Jr.*

Bright Light Reflector Co., Inc.
Fairfield & State, Bridgeport 5, Conn. *C. E. Scholl*

British Columbia Electric Rwy. Co., Ltd.
570 Dunsmuir St., Vancouver, B. C., Canada *H. N. Walters*

Brockton Edison Co.
36 Main St., Brockton 67, Mass. *W. A. Forbush*

Buffalo Niagara Elec. Corp.
Buffalo 3, N. Y. *Jack F. Parsons*

Edward P. Caldwell & Co., Inc.
101 Park Ave., New York 17, N. Y. *E. T. Caldwell*

California Electric Power Co.
P.O. Box 512, Riverside, Calif. *W. S. Fleming*

Cal-Lite, Inc.
12600 S. Yukon Ave., Hawthorne, Calif. *N. L. Ureles*

Calpa Products Co.
4116 Chester Ave., Philadelphia 4, Pa. *Paul C. Calisti*

Cambridge Electric Light Co.
46 Blackstone St., Cambridge 39, Mass. *Reginald H. Bowman*

Canadian General Elec. Co., Ltd.
212 King St., Toronto, Ont. *R. M. Love*

Canadian Laco Lamps, Ltd.
745 Guy St., Montreal, Que. *J. Thomas*

Canadian Line Materials, Ltd.
Postal Station H, Toronto 13, Ont., Canada *L. E. Messinger*

Central Hudson Gas and Elec. Corp.
50 Market St., Poughkeepsie, N. Y. *H. E. Dexter*

Central Illinois Light Co.
316 Jefferson Ave. S., Peoria 2, Ill. *R. K. Dallas*

Central Illinois Public Service Co.
607 E. Adams St., Springfield, Ill. *B. L. Palm*

Central Maine Power Co.
9 Green St., Augusta, Maine *Roland W. Hess*

Central New York Power Corp.
300 Erie Boulevard W., Syracuse, N. Y. *L. D. McCormac*

Central Power & Light Co.
P.O. Box 2121, Corpus Christi, Texas *James M. Williams*

Champion Lamp Works Div. of Consolidated Electric Lamp Co.
600 Broad St., Lynn, Mass. *Ellery H. Raddin*

Cincinnati Gas & Electric Co.
Fourth & Main Sts., Cincinnati 1, Ohio *J. R. Hartman*

Circlite Corp.
118 So. Clinton St., Chicago, Ill. *George Gomberg*

City of Burbank, California Public Service Department
174 W. Magnolia Boulevard, Burbank, Calif. *J. H. McCambridge*

City of Glendale Public Service Dept.
119 N. Glendale Ave., Glendale 6, Calif. *P. Diederich*

City of Riverside Electric Light Dept.
3854 Mulberry St., Riverside, Calif. *L. W. Grayson*

City of Seattle, Dept. of Lighting — Puget Sound
1015 Third Ave., Seattle 4, Wash. *P. C. Spewart*

City of Tacoma, Light Division
Tacoma 2, Wash. *Ray H. Weston*

Colonial Electric Products Co., Inc.
1-115 Market St., E. Paterson, N. J. *Wallace M. Woodworth*

Colonial Premier Co.
466 W. Superior St., Chicago 10, Ill. *Richard Weis*

Commercial Light Co.
841 W. Washington Blvd., Chicago, Ill. *Michael R. Fine*

Commonwealth Edison Co.
72 W. Adams St., Chicago 90, Ill. *Ralph G. Raymond*

The Connecticut Light & Power Co.
250 Freight St., Waterbury 91, Conn.

Consolidated Edison Co. of N. Y., Inc.
4 Irving Place, New York 3, N. Y. *Clarence Law*

Consolidated Gas, Elec. Light & Power Co. of Baltimore
100 W. Lexington St., Baltimore 1, Md. *R. H. Tillman*

Consumers Power Co.
212 Michigan Ave. W., Jackson, Mich. *D. E. Karn*

Consumers Public Power Co.
1452-25th Ave., Columbus, Nebraska *W. H. Sinks*

Corning Glass Works
Corning, N. Y. *A. S. Tylor*

Coyne Electrical School, Inc.
500 So. Paulina St., Chicago 7, Ill. *John Hanan*

Crescent Electric Supply Co.
765 Iowa St., Dubuque, Iowa *Titus B. Schmid*

Crouse-Hinds Co.
Syracuse 1, N. Y. *A. H. Clarke*

Crouse Hinds Co. of Canada, Ltd.
7 Labatt Ave., Toronto, Ont. *F. R. Jeffery*

Curtis Lighting, Inc.
6135 W. 65th St., Clearing Station, Chicago 38, Ill. *Darwin Curtis*

Curtis Lighting of Canada, Ltd.
195 Wicksteed Ave., Leaside, Toronto 12, Ont. *H. L. Wright*

Cutler Light Manufacturing Co.
3026-28 N. 22d St., Philadelphia 21, Pa. *Robert T. Cutler*

Dallas Power & Light Co.
1506 Commerce St., Dallas 1, Texas *W. G. Moore*

Day-Brite Lighting, Inc.
5401 Bulwer St., St. Louis 7, Mo. *D. J. Biller*

The Dayton Power & Light Co.
25 No. Main St., Dayton, Ohio *H. S. Nonneman*

Dazor Manufacturing Corp.
4483 Duncan Ave., St. Louis 10, Mo. *F. L. Read*

Delaware Power & Light Co.
600 Market St., Wilmington 99, Del. *W. A. F. Fyle*

Dept. of Water & Power, City of Los Angeles, Bur. of Power & Light
Box 3669 Terminal Annex, 207 So. Broadway, Los Angeles 54, Calif. *C. P. Garman*

Detroit Edison Co.
2000 Second Ave., Detroit 26, Mich. *L. E. Taylor*

Detroit Steel Products Co.
2250 E. Grand Blvd., Detroit 11, Mich. *W. Clifton Randall*

E. I. duPont de Nemours & Co., Inc. (Fabrics & Finishes Div.)
Wilmington 98, Del. *S. W. Quisenberry*

Duquesne Light Co.
435 Sixth Ave., Pittsburgh 19, Pa. *G. W. Ousler*

Duro Test Corp.
2321 Hudson Blvd., North Bergen, N. J. *James L. Cox*

Eastern Fixture Co., Inc.
170 Vernon St., Boston 20, Mass. *Louis Gilman*

East Side Metal Spinning & Stamping Corp.
1 W. 34th St., New York 1, N. Y. *M. A. Kremer*

(*Note*: Names of Official Representatives appear in Italics)

Ebasco Services, Inc.
2 Rector St., New York 6, N. Y.
W. E. Parrott

Electrical Information Publications, Inc.
20 E. Mifflin, P.O. Box 232, Madison, Wis.
W. N. Dudley

Electrical Testing Laboratories, Inc.
79th St. & East End Ave., New York City 21, N. Y.
Preston S. Millar

Elec. Service Mfg. Co.
17th & Cambria Sts., Philadelphia 32, Pa.
E. A. Leinroth

Electric Supply Corp.
701 W. Jackson Blvd., Chicago 6, Ill.
L. B. Mangione

Electro Manufacturing Corp.
2000 W. Fulton St., Chicago 12, Ill.
L. A. Schoenbrod

Electrolier Mfg. Company, Ltd.
5849 Boyer St., Montreal, Que., Canada.
John Issenman

Ender Manufacturing Corp.
200 West St., New York 13, N. Y.
Jules Levenstein

Electron Corp.
4501 Galapago, Denver, Colo.
Floyd Vickers

Englewood Electrical Supply Co.
5801-03 So. Halsted St., Chicago, Ill.
Ray O'Leary

Famous Fluorescent Light Co.
762 N. Ogden Ave., Chicago 22, Ill.
Jack R. Stone

Federal Electric Company, Inc.
8700 S. State St., Chicago, Ill.
John H. Goehst

Fitchburg Gas & Electric Light Co.
537 Main St., Fitchburg, Mass.
A. G. Neal

Fluorescent Equipment & Mfg. Co.
2570 Superior Ave., Cleveland 14, Ohio
Leonard S. Freeman

Fluorescent Maintenance Co., Inc.
1480 S. Robertson Blvd., Los Angeles 35, Calif.
Leonard K. Black

Fluores-O-Lite Co.
Evans Terminal, No. Broad St., Hillside, N. J.
Meyer H. Silverman

The Fostoria Pressed Steel Corp.
Fostoria, Ohio
E. L. Bates

H. A. Framburg & Co.
3320-28 Carroll Ave., Chicago 24, Ill.
Stanley A. Framburg

The France Mfg. Co.
10325 Berea Rd., Cleveland 2, Ohio
J. H. Mayne

The Frankelite Co.
1425 Rockwell Ave., Cleveland 14, Ohio
Dave Frankel

Franklin Design Service, Division of Safeway Stores, Inc.
4th & Jackson Sts., P.O. Box 660, Oakland 4,
Wallace H. Lane

The Frink Corporation
27-01 Bridge Plaza North, Long Island City, N. Y.
Theo. J. Brassel, Jr.

Gallagher-O'Brien Electric Co., Inc.
712 N. State St., Chicago 10, Ill.
Frank A. Gallagher

Garden City Plating & Mfg. Co.
1750 No. Ashland Ave., Chicago 22, Ill.
G. G. Harney

General Electric Co., Apparatus Dept.
River Works, 920 Western Ave.,
West Lynn, Mass.
A. F. Dickerson

General Electric Co., Lamp Dept.
Nela Park, Cleveland 12, Ohio
Willard C. Brown

General Electric Supply Corp.
1260 Boston Ave., Bridgeport, Conn.
W. W. Booth

General Lighting Products Co.
16 Delancy St., Newark 5, N. J.
Nathan H. Eglowstein

General Outdoor Advertising Co., Inc.
515 So. Loomis St., Chicago, Ill.
R. E. Nevius

The Georgia Power Co.
Electric Building, Atlanta 1, Ga.
Charles A. Collier

Gibson Manufacturing Co.
1919 Piedmont Circle, N. E., Atlanta, Ga.
R. R. Gibson

Gill Glass & Fixture Co.
Amber & Tioga Sts., Philadelphia 34, Pa.
C. A. Gill

Gillinder Brothers, Inc.
Erie & Liberty Sts., Port Jervis, N. Y.
J. Fletcher Gillinder

Gleason-Tiebout Glass Co.
99 Commercial St., Brooklyn 22, N. Y.
Charles W. Gleason

Globe Lighting Products Co., Inc.
397 Seventh Ave., Brooklyn, N. Y.
Isidor Rosenblatt

Golde Manufacturing Co.
1214 West Madison, Chicago 7, Ill.
E. W. Goldberg

Grand Rapids Store Equip. Co.
1340 Monroe Ave., N. W., Grand Rapids 2, Mich.
Kenneth C. Welch

Graybar Electric Co., Inc.
420 Lexington Ave., New York 17, N. Y.
Raymond C. Kinney

Gulf States Utilities Co.
Box 2951, Beaumont, Texas
Clarence Barron

The Edwin F. Guth Co.
2615 Washington Ave., St. Louis 3, Mo.
Fred E. Guth

Hartford Electric Light Co.
266 Pearl St., Hartford 3, Conn.
Victor Ouellette

Hawkins Electric Co.
1447 Washington Blvd., Chicago 7, Ill.
R. R. Hill

Hendrickson-Hefferman Co., Inc.
45-17 Pearson St., Long Island City 1, N. Y.
Joseph T. Manucia

Holdenline Co.
2301 Scranton Rd., Cleveland 13, Ohio
H. E. Ingraham

Holophane Company, Inc.
342 Madison Ave., New York 17, N. Y.
H. L. Logan

Houston Lighting & Power Co.
P.O. Box 1700, Houston 1, Texas
H. O. Clarke

Hydro-Electric Power Comm. of Ont.
620 University Ave., Toronto, Ontario.
R. L. Hearn

Hyland Electrical Supply Co.
700 West Jackson Blvd., Chicago, Ill.
Chas. H. Weicensang

Illinois Power Co.
134 East Main St., (L Box 511 B), Decatur 70, Ill.
Allen Van Wyck

Illuminating Engineering Co.
2347 E. Nine Mile Road, Hazel Park, Mich.
Bert C. Pretzer

Iowa-Illinois Gas & Electric Co.
United Light Bldg., Davenport, Iowa
John M. Hollingsworth

Iowa Public Service Co.
400 Commercial St., Waterloo, Iowa
C. R. Wagener

Jeannette Shade & Novelty Co.
N. Fourth St., Jeannette, Pa.
H. N. Creck

Jefferson Electric Co.
Bellwood, Ill.
L. Maurer

Jersey Central Power & Light Co.
501 Grand Ave., Asbury Park, N. J.
Thomas R. Dobson

Joleco Corporation
2513 Baldwin St., St. Louis, Mo.
George Ledbetter

Jones Metal Products Co.
West Lafayette, Ohio
H. Boyer

Joslyn Mfg. & Supply Co.
3700 So. Morgan St., Chicago 9, Ill.
J. H. Fahey

Kahn Manufacturing Co., Inc.
2051 N. 19th St., Milwaukee, Wis.
Charles F. Kahn

Kansas City Power & Light Co.
P.O. Box 679, Kansas City 10, Mo.
John M. Arthur, Jr.

Kansas Gas & Electric Co.
P.O. Box 204, Wichita, Kans.
H. W. Hobson

The Kawneer Co.
North Front St., Niles, Mich.
Richard M. Spray

The Kayline Company
2480 E. 22nd St., Cleveland 15, Ohio
M. A. Eskins

Kelso-Burnett Electric Co.
223 W. Jackson Blvd., Chicago 6, Ill.
Sigmund A. Hollinger

Keystone Electric Manufacturing Co.
2328-36 E. Tioga St., Philadelphia 34, Pa.
Leonard M. Siegel

The Kirlin Company
3435 E. Jefferson Ave., Detroit 7, Mich.
Ivan Kirlin

Kopp Glass, Inc.
Swissvale, Pa.
F. C. Ashe

Kubec Electric Co.
630 W. Jackson Blvd., Chicago 6, Ill.
Fred A. Girten

The La Salle Lighting Products, Inc.
145 Seneca St., Buffalo 3, N. Y.
Nelson R. Zicherman

Leader Electric Manufacturing Corp.
3500 N. Kedzie St., Chicago 18, Ill.
Walter Glass

The Leeds & Northrup Co.
4901 Stenton Ave., Philadelphia 44, Pa.
I. M. Stein

Libbey Owens Ford Glass Co., Plaskon Division
2112-24 Sylvan Ave., Toledo, Ohio
Dr. M. H. Bigelow

Light Control Company
3217 Casitas Ave., Los Angeles 26, Calif.
Stanley E. Lindahl

Lighting & Lamps
114 East 32nd St., New York 16, N. Y.
James Krieger

Lighting Incorporated
1834 So. Figueroa St., Los Angeles, Calif.
Harry Marsh

Lighting Products, Inc.
2259 W. Park Ave., Highland Park, Ill.
D. E. Dunne

Lightolier Co.
11 East 36th St., New York 16, N. Y.
H. Stollnitz

Line Material Co.
800 North 8th St., Milwaukee 1, Wis.
M. C. Harsh

Litecontrol Corp.
36 Pleasant St., Watertown 72, Mass.
Paul H. Lamson

Louisiana Power & Light Co.
142 Delaronde St., Station "A," New Orleans, La. *C. L. Osterberger*

Luminator, Inc.
120 N. Peoria St., Chicago 7, Ill.
Albert L. Arenberg

T. R. Lyda Manufactnrers Rep.
4922 Washington Blvd., Indianapolis, Ind.
T. R. Lyda

Lynn Gas & Electric Co.
99 Exchange St., Lynn, Mass. *James A. Cook*

Macbeth Corp.
227 West 17th St., New York, N. Y.
Norman Macbeth

Malden Electric Co.
157 Pleasant St., Malden, Mass.
Donald S. Bennett

Markel Electric Products, Inc.
145 E. Seneca St., Buffalo 3, N. Y.
D. L. Ripley

La Cie Martineau Electrique Ltee.
24 rue du Roi, Quebec, Canada
Henri Martineau

Metalcraft Products Company
306-08 Cherry St., Philadelphia 6, Pa.
Alex Abel

Metal Window Institute
Cheltenham, Pa. *George Hingston*

Metropolitan Edison Co.
412 Washington St., Reading, Pa.
E. J. Ingram

Metropolitan Electrical Supply Co.
20 N. Jefferson St., Chicago 6, Ill.
H. J. Privat

Midwest Chandelier Co.
15th & Gentry Sts., No. Kansas City 16, Mo.
Sidney Lefkovitz

The Miller Co.
Meriden, Conn. *G. W. Beals*

Mississippi Glass Co.
220 Fifth Ave., New York City 1, N. Y.
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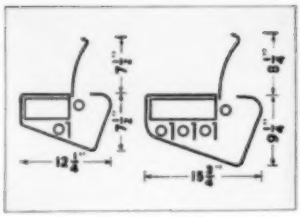

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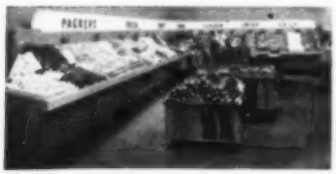

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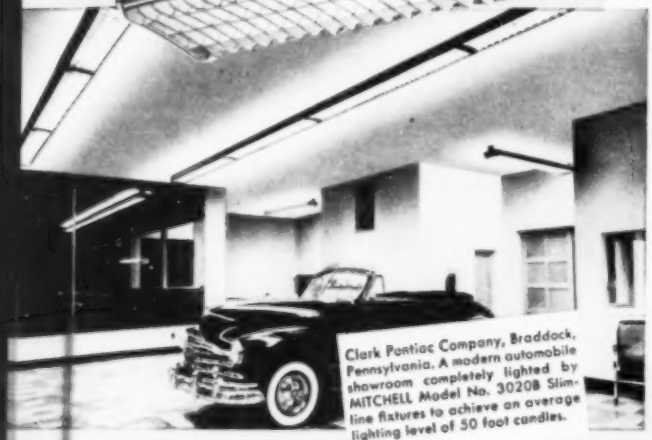

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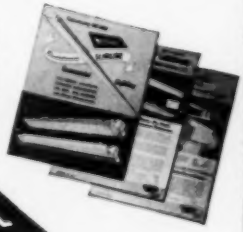

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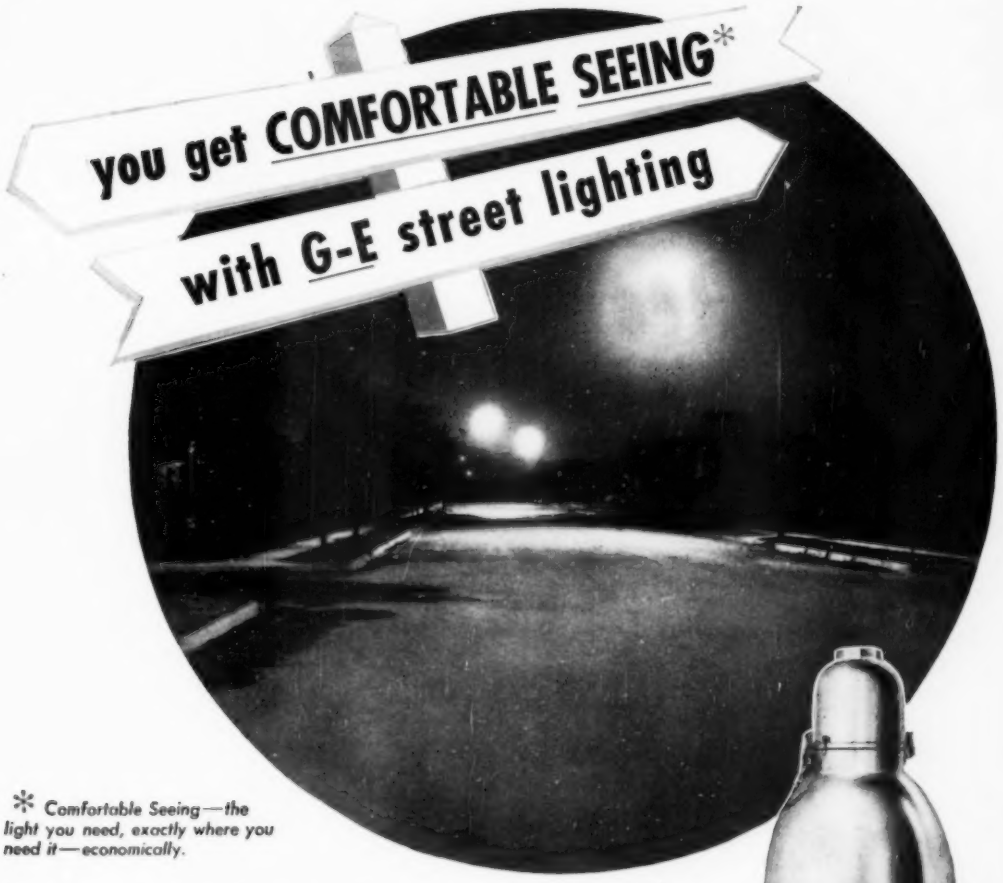

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- **Easy to wire** . . . Stripped and tinned leads can be inserted through the entrance holes in the face of the Turret lampholder. Binding screws are then tightened through the holes in bottom of the lampholder to make permanent pressure contacts.
- **Easy to design in** . . . Turret lampholders can be used in a wide variety of arrangements. They can be mounted singly or in multiple groups. They are available to accommodate two or three lamps.
- **Easy to sell** . . . The pleasing design of Turret lampholders adds to the appearance and the value of any fluorescent lighting fixture. And don't forget, the confidence inspiring General Electric name helps in the sale of any product.

For further information, write to Section Q56-787, Construction Materials Department, General Electric Company, Bridgeport 2, Connecticut.

Now for Slimline lamps

Now, General Electric makes Twin Turret lampholders for two 96-inch Type T-12 Slimline lamps. These new Slimline Turrets have all the big features of the standard line of Turrets.

The slow process of replacing lamps with two hands is out when fixtures are equipped with General Electric Turret lampholders.

There are no clips or safety gadgets to fuss with when your fixtures are equipped with Turrets. Snug fit and uniform spring tension hold lamp securely in place—automatically keep firm contact.

Now, lamp changing is a fast, easy, one-hand operation. And there's no need to worry about breaking lampholders, because Turrets are sturdy, can take rough handling.

This spring action is the secret of the Turret's simplicity of operation. To insert lamp just push in contact plate and turn lamp slightly to seat pins. Swing free end of lamp up and lamp slides firmly into place.

GENERAL ELECTRIC

Continued from page 445

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Continued on page 14A

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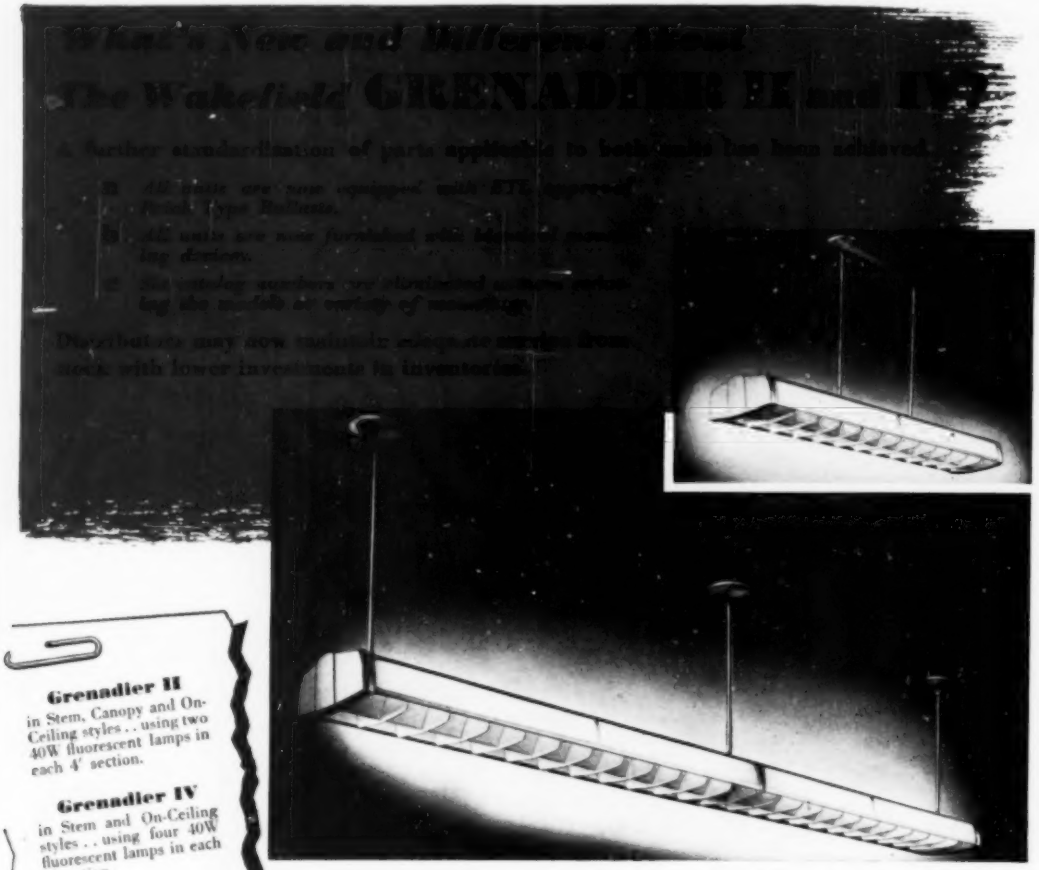

Grenadier II
in Stem, Canopy and On-Ceiling styles . . using two 40W fluorescent lamps in each 4′ section.

Grenadier IV
in Stem and On-Ceiling styles . . using four 40W fluorescent lamps in each 4′ section.

In classroom, office, drafting room and store installations the Wakefield Grenadier has earned respect for

1. ***its ability to provide a highly efficient type of diffused lighting;***
2. ***design and construction features which make maintenance and part replacement simple and rapid, resulting in a "low cost of owning";***
3. ***the quality and beauty of its construction throughout and particularly of the metal-framed plastic side panels and the soft metallic satin finish of all metal parts.***

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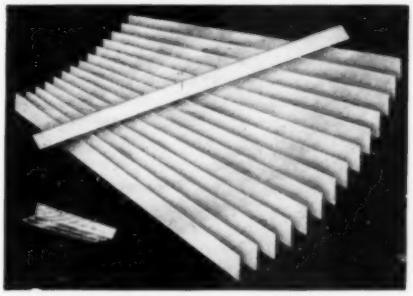
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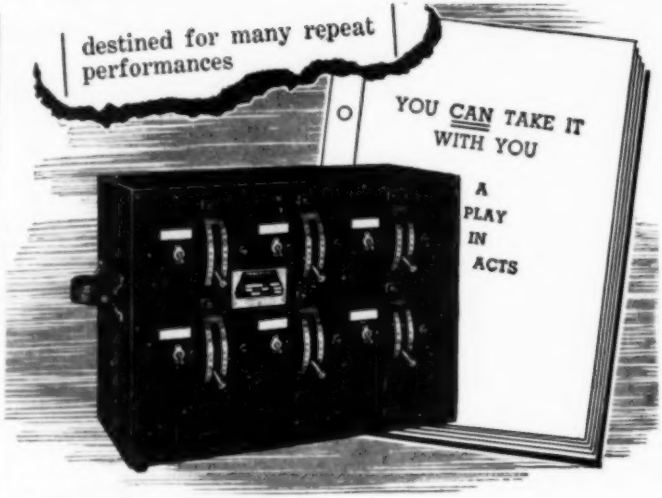

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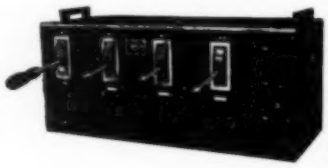
To give that stage production a professional, big-theatre atmosphere, use the handy *portable*, "PACKAGED" POWERSTAT Dimmers to dim, brighten and blend stage lighting. School, church, community and amateur theatrical groups, as well as small theatres, find these POWERSTAT Dimmers ideal . . . offering the facilities of large switchboard installations at a fraction of the cost.

Type DBR6-850 provides six efficient 850-watt dimmers built into a compact, black wrinkle-finished cabinet. Each dimmer operates independently to handle six different lighting circuits. This multi-circuit dimmer features simple installation, minimum maintenance, complete protection and easy, economical operation. A separate fuse protects each of the 6 circuits; each has its individual "on-off" switch, indicating light and output receptacle. Overall dimensions are 14½" x 18⅞" x 9¼". Reinforced carrying straps facilitate moving the unit from one location to another.

Another portable, "PACKAGED", multi-circuit POWERSTAT Dimmer is Type DBP3-1700. Consists of Three 1700-watt dimmers in one efficient cabinet. Each dimmer in this handy "package" can be mechanically interlocked to a master control for group operation. Dimensions: 15⅛" x 36⅛" x 13". Handles, supplied for ease in carrying, are removable to allow for gang mounting when more than three circuits are to be controlled.



Send for information on these two portable, "PACKAGED" POWERSTAT Dimmers . . . also for details on the complete line of POWERSTAT Dimmers — manually operated or motor-driven — built to meet every lighting control need.

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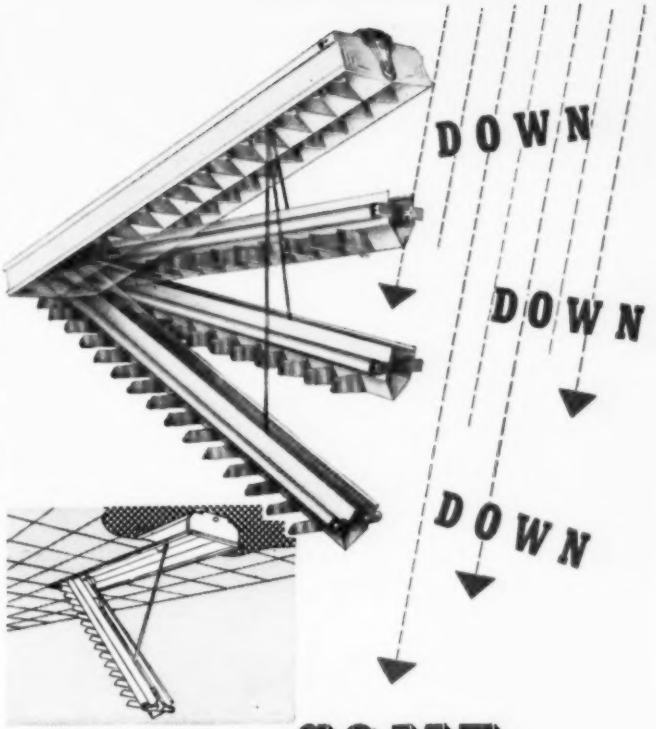

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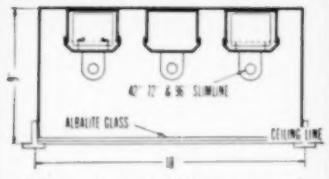
How new lighting helped increase business here 136%

BUSINESS has more than doubled at this Thompson restaurant (Chicago) since remodeling and relighting. A good share of the credit goes to the General Electric slimline fluorescent lamps in attractive, modern fixtures over the entrance and just inside the front window.

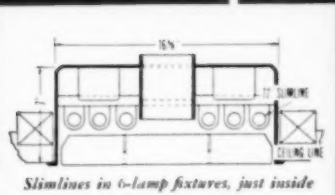
Their high light output attracts customers' attention. The long, unbroken lines of light give a clean, modern effect. Other G-E slimline features important to the owners are instant starting (no starters needed), ease and economy of maintenance, and long life.

Slimline fluorescent is another product of General Electric lamp research—the research that works constantly to make G-E lamps STAY BRIGHTER LONGER.

SLIMLINE FLUORESCENT LAMPS

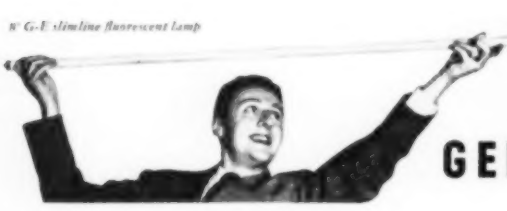


Slimline lamps highlight entrance. Use of 3 sizes permits curved effect.



Slimlines in 6-lamp fixtures, just inside front window, attract customers.

96" G-E slimline fluorescent lamp



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G-45-30-2-P

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3. Coefficients of Utilization
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